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EFFECTS OF ARRIVAL TIME ERRORS IN WEIGHTED RANGE EQUATION SOLUTIONS FOR LINEAR BASE SOUND RANGING

APRIL 1979

By

DONALD M. SWINGLE

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US Army Electronics Research and Development Command
Atmospheric Sciences Laboratory
White Sands Missile Range, NM 88002

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Results of the research discussed in this report show that the errors in target location computed by the Weighted Range Equation Solution, when applied to a regular, linear, six-microphone array, are approximately proportional to the errors in arrival time, relative to the assumptions inherent in the solution model. For most target locations, microphones 2 and 5, in the six-microphone array, are relatively less influential in determining target location than are microphones 1, 3, 4, and 6. The transfer function between arrival time errors over

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20. ABSTRACT (cont)

at one or more microphones is shown to be approximately linear and to possess the property of superposability; i.e., the combined effect of several errors in arrival time is approximately equal to the sum of the effects of each error taken as occurring alone. Several general properties of symmetry and anti-symmetry are demonstrated.

This report provides its readers with the basic vector error response of the Weighted Range Equation Solution for all areas in which the AN/TNS-10 Sound Ranging Set is effective.

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INTRODUCTION

Linear base sound ranging, using the GR-8 or AN/TNS-10 Sound Ranging Set, has been shown to be an effective means for locating enemy firing batteries which are beyond the range of direct visual observation. Development of the USRAN3 solution technique by Swingle, Bellucci, and Crenshaw showed that the present system was not performing to the limits of its accuracy potential. Their evaluations showed that an improvement in accuracy from 2.2 percent of range* to 1.8 percent could be achieved by a simple change in the method by which the final target location (fix) was computed.[1,2] They noted that further improvements were believed to be achievable.

In response to a request from US Army Materiel Command Headquarters in June 1974, Swingle developed an error analysis for the overall system which was used to estimate the likely improvement which could be achieved for a typical target located centrally to the microphone array and 10,000 meters ahead thereof. This restriction of target location was adopted for reasons of both simplicity and nonavailability of quantitative error sensitivity data for other locations.

The present report covers the first steps in expanding that analysis to include the entire field of potential target locations, including extension of the analysis to points beyond the usual range of sound ranging utility, i.e., to ranges exceeding twice the base length and to flanking angles beyond 15 degrees from the normal of the outlying subbases.

This analysis will develop the ultimate accuracy which can be expected from a variety of sound ranging array configurations having tactical practicality, including, of course, the six-microphone "linear base" system with which the US Army is now equipped. Optimized meteorological correction methods, which take account of the natural variability of the atmosphere, will be considered as parts of the overall sound ranging system input error source.

It will be assumed that the reader is generally acquainted with the principles of sound ranging on artillery weapons based on the use of the AN/TNS-10 or similar system. All six microphones will be assumed to be installed along a straight base at uniform spacings of four sound seconds (about 1350 meters). While solutions for shot time and shot coordinates are unique, within the usual assumptions of an atmosphere having uniform

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*Distance target is forward of line of microphones

[1]Donald M. Swingle, Craig M. Crenshaw, and Raymond Bellucci, 1972, "Improved Sound Ranging Location of Enemy Artillery," Army Science Conference, US Military Academy, West Point, NJ

[2]Donald M. Swingle and Raymond Bellucci, 1973, "Improved Sound Ranging Location of Enemy Artillery," R&D Technical Report ECOM-5486, US Army Electronics Command, Fort Monmouth, NJ

wind and uniform temperature (sound speed), when arrival times from only three microphones are used to determine target location, the system is over-determined when more than three arrival times are used. Under these conditions a number of solution methods can be used, yielding generally different target locations.

Following the development and evaluation of the USRAN3 solution, Crenshaw and Swingle engaged in a continuing verbal and correspondence exchange,[3,4] looking forward to a more general and even more accurate solution and meteorological correction method. This led to the evolution of the Weighted Range Equation Solution (WRAS) which is outlined in the appendix. In brief, this method determines the shot time and coordinates which minimize the sum of the squares of the differences between the square of the geometric range from solution point to each microphone and the square of the "propagation range" computed from the speed of sound along that direction and the difference between computed shot time and measured arrival time.

$$\sum_{i=1}^{N} W_i \times \left(R_i^2 - P_i^2\right)^2 = \text{minimum} \qquad (1)$$

where W_i is a weighting factor which may be varied by any desired rule across the microphone array. A simple form for the W_i which was suggested by the known behavior of atmospheric variability as studied by Arnold and Bellucci[5] and later by Lowenthal and Bellucci[6] is

$$W_i = R_i^n \Big/ \sum_{i=1}^{N} R_i^n \qquad (2)$$

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[3]Personal communications between Dr. Craig M. Crenshaw and Dr. Donald M. Swingle, June 1972-December 1973

[4]Craig M. Crenshaw, 1972, "Sound Ranging Calculations," AMC Chief Scientist Technical Note Number 1, US Army Materiel Command, Alexandria, VA

[5]A. Arnold and R. Bellucci, 1957, "Variability of Ballistic Meteorological Parameters," Technical Memorandum M-1913, US Army Signal Engineering Laboratories, Fort Monmouth, NJ

[6]Marvin J. Lowenthal and Raymond Bellucci, 1970, "Variability of Ballistic Winds, R&D Technical Report ECOM-3259, US Army Electronics Command, Fort Monmouth, NJ

where n is any real number. Experimentation was conducted with n ranging from 0 to -10. When applied to actual sound ranging data, n = -5 generally gave the most accurate target locations. In the present study this weighting was used, but the conclusions are equally valid when solutions are computed using n = 0.

Earlier studies of sound ranging system error sensitivity had been conducted by Fox,[7] Lee,[8] and Bellucci.[9,10]

All the above utilized solutions depended upon use of <u>differences</u> in arrival time at adjacent microphones. Fox used a least squares minimization of the differences between "true" and perturbed arrival time differences, while Lee minimized the squared differences between "true" and perturbed arrival times. Bellucci used the standard artillery solution. Bellucci's published work was confined to a set of only 12 points in the target area. Lee expressed errors as radial errors (i.e., miss-distance), thus precluding consideration of the vector nature of the error patterns. Fox considered radial and tangential errors relative to the center of the microphone array. Lee presented total radial error contours but provided no data on vector error. None of the researchers provided a dense, ordered array of errors at target points throughout the battle area which might be utilized for error analysis of both current and future tactical sound ranging systems.

Results obtained herein are in generally good agreement with these studies. They differ in that they present error transfer properties of the WRAS solution in terms of along-array and along-normal components. They also extend the range of the computations to at least five sound base (25 subbase) lengths ahead of the array and to 9 to 18 subbase lengths to either side of the centerline of the array. Additional computations, not covered in detail here, extend the computations out as far as 15 sound base (75 subbase) lengths forward of the array. The properties of linearity and superposability discussed below were also found to extend to such ranges, although

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[7]H. L. Fox, 1968, "Meteorological Techniques for Sound Ranging; Theory of Errors," Technical Report ECOM-0233-2, US Army Electronics Command, Fort Monmouth, NJ

[8]Robert P. Lee, 1972, "Artillery Sound Ranging Computer Simulations," R&D Technical Report ECOM-5441, US Army Electronics Command, White Sands Missile Range, NM

[9]Raymond Bellucci, 1966, "Studies of Meteorological Techniques for Sound Ranging: Report II, Error Analysis," Technical Report ECOM-2703, US Army Electronics Command, Fort Monmouth, NJ

[10]Personal communications between Raymond Bellucci and Dr. Donald M. Swingle, June 1966-June 1972

errors were generally much larger. These results will be utilized in succeeding reports dealing with errors in microphone position and atmospheric input as well as terrain effects and sound ranging system improvement.

DATA PRESENTATION

The data of this report are uniformly presented as fields of numerical values, to provide, in a reasonably compact form, the detailed information required to assess the effects of various error sources on target location. Those readers whose taste leads to the representation of data in contour maps are invited to add their own analyses of the numerical fields presented. Both horizontal components of target location error are presented at each grid point to facilitate ready analysis of the vector character of the target location error associated with input data errors.

DATA INTERPRETATION

Figure 1 provides a schematic guide to interpretation of the following tables. Tables 1 through 23 provide the field of target location errors due to specified errors in arrival time at given microphones for each of a regular array of assumed "true" target locations. The targets are assumed to be at the points indicated by "+" (except along the left-hand edge of the figure).

These points are uniformly spaced by one subbase length forward of the center of each subbase and laterally from the center of the array. To the left of each target point appear two figures. The upper number is the error in meters which would arise in the solution by WRAS for the target along the X- or along baseline direction, while the lower number is the error in the Y- or normal-to-baseline direction.

Along the top of each figure are listed the subbase length (BL) in sound seconds (4 sound seconds is approximately 1350 meters) and the index number of the perturbed microphone (IP, counting from left to right as one faces the target from the baseline). In this report IP will range from 1 to 6. If two digits are given under IP, these digits indicate the two microphones whose arrival times are simultaneously perturbed. ID is used to indicate the perturbed parameter and will always be 8 in this report, indicating that the perturbation considered is in time of arrival at the microphones indicated by IP. The number of subbase lengths to the right of the array center which characterizes the top row of targets (+) is given by M. As the computations progress down the page, M is incremented for each row and appears at the left-hand edge of the paper abreast of the Y-component of error. Just above these changing values of M appears the value of IP given in the heading line. This value appears just to the left of the first + in each row which marks the point which is M subbase lengths from the array center. In all of the tables N = 25, indicating that the right-most + or target position in each row is 25 subbase lengths

forward of the microphone array. DXY indicates the spacing in both X and Y directions of the grid points in units one subbase long. In all tables herein DXY is 1.000. UP gives the assumed unit perturbation which is applied to the arrival time of the identified microphone(s) expressed in milliseconds. IW is the weighting exponent. In terms of equation (2), n = -IW. IW will always be 5 herein. ZZ gives the target height above the plane containing the microphones and is always 0.0 in this report. V1, V2, and V3 are the X-, Y-, and Z- components of the mean wind assumed in the computation, and will remain 0.00 in this report. Finally, TE is the assumed "effective temperature" for sound ranging, assumed to be 10°C herein.

Where **** appears on the tables, the error exceeds ±999.5 meters, while $\begin{smallmatrix}-0+\\-0\end{smallmatrix}$ appearing in the upper and lower left corners indicates that computations were not made for the point because it occurs at a large flanking angle ($|M| > N + 3$).

EFFECT OF UNIT INPUT ERRORS ON SOLUTIONS

In computing the data for tables 1 through 15, the author assumed that the target was at the plotted grid point, and the arrival time of sound generated at shot time (= 0.000 seconds) was computed for each microphone. Then the arrival time at the specified microphone (IP) was incremented by UP milliseconds, and the target location was computed by using the WRAS solution. At the field point the difference between the computed location and the assumed or "true" location is printed (computed - true). In tables 1 through 6 of "error maps," the unit perturbation was assumed to be 1 millisecond. All errors are rounded to the nearest meter. This value was chosen as small enough to produce few errors exceeding 1000 meters, while also producing few errors less than a few meters in at least one of the component directions. The reader is invited to examine the symmetry of error effects between microphones 1 and 6 (tables 1 and 6), 2 and 5 (tables 2 and 5) and 3 and 4 (tables 3 and 4).

The tables show that errors in arrival time at microphones 2 and 5 have relatively small effects at most target points on either component of target location error and that for all microphones the Y-component error is generally several times the X-component error. Further, both microphones 1 and 6 yield large negative Y-component errors for a small positive change in arrival time, while both microphones 3 and 4 yield large positive errors in Y-component for a small positive change in arrival time.

In the above computations and throughout this report, it does not matter whether the "error" in arrival time be the result of an error in reading the acoustic record or the effect of propagation phenomena in causing the signature's apparent arrival time to be different from that which would be expected after correcting for the assumed meteorological conditions. Either cause will result in the same target location error if it

causes the same error in arrival time. For example, at the point M = -9, N = 25, the upper right-hand + in table 1, one finds that an arrival time error of 1 millisecond (UP = 1.00) causes the X-component of target position to be computed to be 18 meters larger than true and the Y-component to be computed to be 49 meters smaller than true (18, -49). For the same point, tables 2 through 6 show that the same unit error, if it occurs at microphones 2 through 6, produces target location errors of (-5, 17), (-14, 40), (-11, 31), (-1, 1), and (13, -41) meters, respectively.

LINEARITY OF ERROR TRANSFER FUNCTIONS

The analysis of the joint effects of several error sources on the overall sound ranging target location error would be much simplified if the output error could be assumed to be linearly dependent upon the input error, or at least approximately so. Tables 2 through 6 show the error fields for input errors of 1 millisecond occurring in microphones 1 through 6, while tables 7 through 12 show the error fields for input errors of 3 milliseconds.

In view of the symmetry noted for errors in microphones 1 and 6, 2 and 5, and 3 and 4, it becomes apparent that the entire story can be told by just the error fields due to microphones 1, 2, and 3. Thus the error fields due to input errors of 10 and 30 milliseconds, shown in tables 13 through 15 and 16 through 18, respectively, are shown only for microphones 1, 2, and 3.

Through most of the error field, output errors in each horizontal component of target location are approximately proportional to input errors. Over a range of 30:1 in input error, proportionality is quite good. The range selected for illustration includes the range of errors to be expected because of normal atmospheric propagation effects and from errors in reading arrival time records.

In assessing the combined effects of several errors affecting the measured arrival time at any microphone, little error will occur if the target location error due to each contributing error is separately computed and the results summed instead of first summing the several contributing errors in arrival time and then computing the target location error which they will cause.

SUPERPOSABILITY OF ERROR TRANSFER FUNCTIONS

The preceding section demonstrated that several simultaneous arrival time errors occurring at a single microphone could be separately transformed into target location errors and then summed to give the aggregate target location error. To investigate the validity of computing errors due to simultaneous arrival time errors in several microphones as the sum of the effects of errors in each microphone, the author assumed errors occurring in one microphone and an additional error occurring in each of the remaining microphones in turn.

In tables 19 through 23, simultaneous errors of 3 milliseconds are assumed to occur in microphone 2 and in microphones 1, 3, 4, 5, and 6 in turn. The reader will be able to readily verify that the effect of the combined simultaneously occurring error is very closely approximated by the sum of the errors given table 8 and tables 7, 9, 10, 11, and 12, respectively.

For example, tables 7 through 12 show that the errors in target location at the point (M, N) = (-9, 25) due to a 3-millisecond error in arrival time at microphones 1 through 6 are (56, -147), (-15, 50), (-42, 120), (-34, 93), (-3, 2), and (40, -124) meters, respectively. For the same target point, table 19 shows that the target location error due to simultaneously occurring 3-millisecond errors in microphones 1 and 2 is (40, -95), almost exactly the sum of the effects of this error acting separately at microphones 1 and 2. The corresponding effect of the combined error in microphones 2 and 3, 2 and 4, 2 and 5, and 2 and 6 are (-58, 172), (-50, 145), (-19, 53) and (15, -74) meters, respectively, as shown in tables 20 through 23. In each case the effect of the simultaneously occurring error is approximately equal to the sum of the effects caused by each error taken as acting alone. Similar results would be found for any selected group of microphones and for any target point.

We have thus shown that the errors in target location resulting from the simultaneous presence of errors in several microphones can be closely approximated by the sum of errors computed as if each error occurred separately in each of the microphones.

CONCLUSIONS

The above analysis has shown that sound ranging solutions obtained by the WRAS solution technique applied to a regular, linear, six-microphone array have the following properties:

1. Errors occurring in arrival time, relative to the assumptions inherent in the solution model, in microphones 1, 3, 4, and 6 have the greatest effect on the solution; while at most field points, microphones 2 and 5 have relatively little effect on the solution.

2. At most field points, the Y-component of target location error due to an error in arrival time at any microphone is generally several times as large as the X-component of error.

3. Positive errors in arrival time at microphones 1 and 6 lead generally to negative Y-component errors, while positive errors in arrival time at microphones 3 and 4 result in positive Y-component errors.

4. Positive errors in arrival time at microphones 1 and 6 lead to positive X-component errors in target locations for left flank targets and negative X-component errors in target locations for right flank targets, while positive errors in arrival time at microphones 3 and 4 lead to positive X-component errors in target location for right flank targets and negative X-component errors in target location for left flank targets.

5. For each horizontal component of target location, the error caused by an error in arrival time at any microphone is approximately proportional to the arrival time error; i.e., the time-to-space error transfer function is approximately linear. Thus the error in target location due to the combined effects of several errors in arrival time at any one microphone is closely approximated by the sum of errors in target location which each of the contributing errors would have caused if acting alone.

6. The error in target location in each component of position resulting from simultaneously occurring errors at two or more microphones is closely approximated by the sum of the errors which each arrival time error would produce if acting alone; i.e., the error contributions are superposable in geometric space.

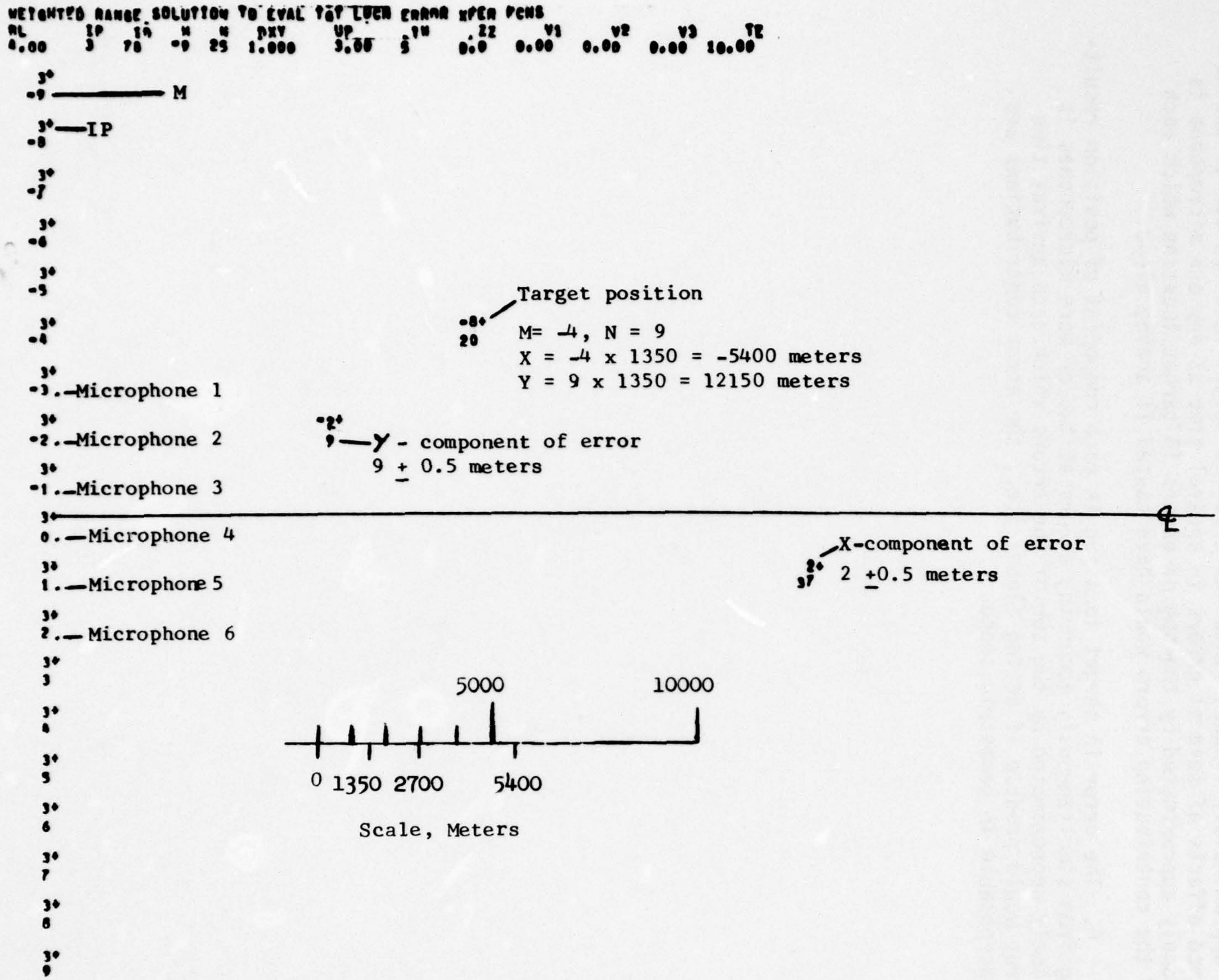

Figure 1. Key to error maps, tables 1 through 23.

TABLE 1. X- AND Y-COMPONENT ERRORS DUE TO A 1-MILLISECOND ERROR IN ARRIVAL TIME AT MICROPHONE 1

WEIGHTED RANGE SOLUTION TO EVAL TGT LOCN ERROR XFER FCNS

BL	IP	ID	M	N	DXV	UP	IN	ZZ	V1	V2	V3	TE
4.00	1	8	-9	25	1.000	1.00	5	0.0	0.00	0.00	0.00	10.00

1+	-0+	-0+	58+	43+	32+	26+	22+	20+	18+	17+	16+	16+	16+	16+	16+	16+	16+	16+	16+	17+	17+	17+	18+	18+	18+
-9	-0	-0	-23	-19	-18	-17	-17	-17	-18	-18	-19	-21	-22	-23	-25	-27	-29	-31	-33	-35	-38	-40	-43	-46	-49
1+	-0+	85+	43+	29+	22+	18+	16+	14+	14+	13+	13+	13+	13+	13+	13+	13+	13+	13+	14+	14+	14+	15+	15+	15+	16+
-8	-0	-22	-15	-14	-14	-13	-14	-14	-15	-16	-17	-18	-20	-21	-23	-25	-27	-29	-31	-33	-36	-38	-41	-44	-47
1+	165+	49+	26+	18+	14+	12+	11+	10+	10+	10+	10+	10+	10+	10+	10+	10+	11+	11+	11+	12+	12+	12+	13+	13+	13+
-7	-25	-14	-11	-10	-10	-11	-11	-12	-13	-14	-15	-16	-18	-19	-21	-23	-25	-27	-29	-31	-34	-36	-39	-42	-45
1+	81+	25+	14+	11+	9+	8+	8+	7+	7+	7+	7+	7+	8+	8+	8+	8+	9+	9+	9+	9+	10+	10+	10+	11+	11+
-5	-15	-9	-8	-7	-8	-8	-9	-10	-11	-12	-13	-14	-16	-17	-19	-21	-23	-25	-27	-30	-32	-35	-37	-40	-43
1+	31+	11+	7+	6+	6+	5+	5+	5+	5+	5+	5+	6+	6+	6+	6+	6+	7+	7+	7+	8+	8+	8+	9+	9+	9+
-5	-7	-5	-5	-5	-6	-6	-7	-8	-9	-10	-11	-12	-14	-16	-18	-19	-21	-24	-26	-28	-31	-33	-36	-39	-42
1+	8+	4+	3+	3+	3+	3+	3+	3+	3+	4+	4+	4+	4+	4+	5+	5+	5+	5+	6+	6+	6+	6+	7+	7+	7+
-4	-2	-2	-3	-4	-4	-5	-6	-7	-8	-9	-10	-11	-13	-15	-16	-18	-20	-22	-24	-27	-29	-32	-35	-37	-40
1+	1+	1+	1+	2+	2+	2+	2+	2+	2+	2+	3+	3+	3+	3+	3+	4+	4+	4+	4+	4+	5+	5+	5+	5+	5+
-3	0	-1	-2	-3	-3	-4	-5	-6	-7	-8	-9	-10	-12	-14	-15	-17	-19	-21	-23	-26	-28	-31	-34	-36	-39
1+	0+	0+	1+	1+	1+	1+	1+	1+	1+	1+	2+	2+	2+	2+	2+	2+	2+	3+	3+	3+	3+	3+	3+	4+	4+
-2	0	-1	-1	-2	-2	-3	-4	-5	-6	-7	-8	-10	-11	-13	-14	-16	-18	-20	-23	-25	-27	-30	-33	-36	-38
1+	0+	0+	0+	0+	0+	0+	0+	0+	1+	1+	1+	1+	1+	1+	1+	1+	1+	1+	2+	2+	2+	2+	2+	2+	2+
-1	0	0	-1	-1	-2	-2	-3	-4	-5	-6	-7	-9	-10	-12	-14	-16	-18	-20	-22	-24	-27	-29	-32	-35	-38
1+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+	1+	1+	1+	1+	1+
0	0	0	0	-1	-1	-2	-3	-3	-5	-6	-7	-8	-10	-11	-13	-15	-17	-19	-21	-24	-26	-29	-32	-34	-37
1+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+
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1+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+	-1+	-1+	-1+	-1+	-1+	-1+	-1+	-1+	-1+	-1+
2	0	0	0	0	-1	-1	-2	-3	-4	-5	-6	-8	-9	-11	-13	-15	-17	-19	-21	-23	-26	-28	-31	-34	-37
1+	0+	0+	0+	0+	0+	0+	0+	0+	0+	-1+	-1+	-1+	-1+	-1+	-1+	-1+	-2+	-2+	-2+	-2+	-2+	-2+	-2+	-3+	-3+
3	0	0	0	0	-1	-1	-2	-3	-4	-5	-6	-8	-9	-11	-13	-15	-17	-19	-21	-23	-26	-28	-31	-34	-37
1+	0+	0+	0+	0+	0+	0+	-1+	-1+	-1+	-1+	-1+	-2+	-2+	-2+	-2+	-2+	-3+	-3+	-3+	-3+	-3+	-4+	-4+	-4+	-4+
4	0	0	0	0	-1	-1	-2	-3	-4	-5	-7	-8	-10	-11	-13	-15	-17	-19	-21	-24	-26	-29	-31	-34	-37
1+	-2+	-1+	0+	0+	-1+	-1+	-1+	-1+	-2+	-2+	-2+	-2+	-3+	-3+	-3+	-3+	-4+	-4+	-4+	-4+	-5+	-5+	-5+	-6+	-6+
5	0	0	0	-1	-1	-2	-3	-3	-5	-6	-7	-8	-10	-12	-13	-15	-17	-19	-22	-24	-26	-29	-32	-35	-38
1+	-7+	-3+	-2+	-1+	-1+	-2+	-2+	-2+	-2+	-3+	-3+	-3+	-4+	-4+	-4+	-5+	-5+	-5+	-6+	-6+	-6+	-6+	-7+	-7+	-7+
6	-2	-1	-1	-1	-2	-2	-3	-4	-5	-6	-8	-9	-10	-12	-14	-16	-18	-20	-22	-25	-27	-30	-32	-35	-38
1+	-25+	-7+	-4+	-3+	-3+	-3+	-3+	-3+	-4+	-4+	-4+	-4+	-5+	-5+	-6+	-6+	-6+	-7+	-7+	-7+	-8+	-8+	-8+	-9+	-9+
7	-4	-2	-2	-2	-3	-3	-4	-5	-6	-7	-8	-10	-11	-13	-15	-17	-19	-21	-23	-25	-28	-30	-33	-36	-39
1+	-0+	-15+	-9+	-6+	-5+	-5+	-5+	-5+	-5+	-5+	-6+	-6+	-6+	-7+	-7+	-7+	-8+	-8+	-8+	-9+	-9+	-10+	-10+	-11+	-11+
8	-0	-5	-4	-4	-4	-4	-5	-6	-7	-8	-9	-11	-12	-14	-16	-17	-19	-22	-24	-26	-29	-31	-34	-37	-40
1+	-0+	-0+	-15+	-11+	-8+	-7+	-7+	-7+	-7+	-7+	-7+	-8+	-8+	-8+	-9+	-9+	-9+	-10+	-10+	-11+	-11+	-12+	-12+	-12+	-13+
9	-0	-0	-5	-6	-6	-6	-6	-7	-8	-9	-11	-12	-13	-15	-17	-19	-21	-23	-25	-27	-30	-32	-35	-38	-41

TABLE 2. X- AND Y-COMPONENT ERRORS DUE TO A 1-MILLISECOND ERROR IN ARRIVAL TIME AT MICROPHONE 2

WEIGHTED RANGE SOLUTION TO EVAL TGT LOCN ERROR KFEH FCNS

BL	T2	IO	W	N	DXY	UP	TA	ZZ	V1	V2	V3	TE
4.00	2	5	-9	25	1.000	1.00	5	0.0	0.00	0.00	0.00	10.00

2*	[illegible]	-0*	-87*	-52*	-35*	-26*	-20*	-16*	-14*	-12*	-10*	-9*	-8*	-8*	-7*	-7*	-6*	-6*	-5*	-5*	-5*	-5*	-5*	-5*	-5*
-9	[illegible]	-0	33	26	22	19	17	16	15	15	14	14	14	14	14	14	14	14	14	15	15	15	16	16	17
2*	[illegible]	-125*	-50*	-36*	-25*	-18*	-14*	-12*	-10*	-9*	-8*	-7*	-6*	-6*	-5*	-5*	-5*	-4*	-4*	-4*	-4*	-4*	-4*	-4*	-4*
-8	[illegible]	35	26	20	18	16	14	13	13	12	12	12	12	12	12	12	12	13	13	13	14	14	15	15	[illegible]
2*	-294*	-77*	-38*	-23*	-16*	-12*	-10*	-8*	-7*	-6*	-5*	-5*	-4*	-4*	-4*	-4*	-3*	-3*	-3*	-3*	-3*	-3*	-3*	-3*	-3*
-7	51	27	19	15	14	12	12	11	10	10	10	10	10	10	10	10	11	11	11	12	12	12	13	13	14
2*	-155*	-43*	-22*	-14*	-10*	-8*	-6*	-5*	-5*	-4*	-3*	-3*	-3*	-3*	-2*	-2*	-2*	-2*	-2*	-2*	-2*	-2*	-2*	-2*	-2*
-6	38	13	14	12	11	10	9	9	8	8	8	8	8	8	9	9	9	9	10	10	11	11	12	12	13
2*	-68*	-21*	-12*	-8*	-8*	-5*	-4*	-3*	-3*	-2*	-2*	-2*	-2*	-2*	-1*	-1*	-1*	-1*	-1*	-1*	-1*	-1*	-1*	-1*	-1*
-5	20	12	10	9	8	7	7	7	7	6	7	7	7	7	7	7	8	8	9	9	9	10	10	11	11
2*	-22*	-9*	-5*	-4*	-3*	-2*	-2*	-2*	-1*	-1*	-1*	-1*	-1*	-1*	-1*	-1*	-1*	-1*	-1*	-1*	0*	0*	0*	0*	0*
-4	9	7	6	6	6	5	5	5	5	5	5	5	5	6	6	6	7	7	7	8	8	9	9	10	10
2*	-4*	-2*	-2*	-1*	-1*	-1*	-1*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*
-3	3	4	4	4	4	3	3	3	3	4	4	4	4	4	5	5	5	6	5	7	7	8	8	9	9
2*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*
-2	1	2	2	2	2	2	2	2	2	2	3	3	3	3	4	4	4	5	5	6	6	7	7	8	8
2*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*
-1	0	0	0	0	0	0	1	1	1	1	1	2	2	2	3	3	3	4	4	5	5	6	6	7	7
2*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*
0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	2	2	3	3	3	4	4	5	5	6	7
2*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*
1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	2	2	3	3	4	4	5	5	6
2*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	1*	1*	1*	1*
2	0	0	0	0	-1	-1	-1	0	0	0	0	0	0	0	0	1	1	1	2	2	3	3	4	4	5
2*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	1*	1*	1*	1*	1*
3	0	0	0	0	-1	-1	-1	-1	-1	-1	-1	0	0	0	0	0	0	1	1	2	2	3	3	4	4
2*	-1*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	1*	1*	1*	1*	1*
4	0	0	0	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	0	0	0	0	0	0	1	1	2	2	3	4
2*	-5*	-2*	-1*	-1*	-1*	-1*	-1*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	1*	1*	1*	1*
5	-1	-1	-1	-1	-1	-2	-2	-2	-2	-2	-2	-1	-1	-1	-1	0	0	0	0	0	1	1	2	2	3
2*	-15*	-5*	-3*	-2*	-2*	-1*	-1*	-1*	-1*	-1*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	1*	1*	1*	1*
6	-4	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-1	-1	-1	0	0	0	0	1	1	2	2
2*	-38*	-11*	-6*	-4*	-3*	-2*	-2*	-2*	-1*	-1*	-1*	-1*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	1*	1*	1*
7	-7	-4	-3	-3	-3	-3	-3	-3	-3	-3	-3	-3	-2	-2	-2	-1	-1	-1	0	0	0	0	1	1	2
2*	[illegible]	-20*	-10*	-7*	-5*	-4*	-3*	-3*	-2*	-2*	-1*	-1*	-1*	-1*	0*	0*	0*	0*	0*	0*	0*	0*	0*	1*	1*
8	[illegible]	-5	-5	-4	-4	-4	-4	-4	-4	-3	-3	-3	-3	-3	-2	-2	-2	-1	-1	0	0	0	0	1	1
2*	[illegible]	[illegible]	-17*	-10*	-7*	-6*	-5*	-4*	-3*	-3*	-2*	-2*	-1*	-1*	-1*	0*	0*	0*	0*	0*	0*	0*	0*	1*	1*
9	[illegible]	[illegible]	-7	-6	-5	-5	-5	-4	-4	-4	-4	-4	-3	-3	-3	-3	-2	-2	-1	-1	-1	0	0	0	1

TABLE 3. X- AND Y-COMPONENT ERRORS DUE TO A 1-MILLISECOND ERROR IN ARRIVAL TIME AT MICROPHONE 3

WEIGHTED RANGE SOLUTION TO EVAL TGT LOCN ERROR XFER FCNS

AL	IP	ID	M	N	DXY	UP	SIN	ZZ	V1	V2	V3	TE
4.00	3	8	-9	25	1.000	1.00	5	0.0	0.00	0.00	0.00	10.00

3*	-0*	-0*	-23*	-17*	-15*	-13*	-19*	-12*	-12*	-11*	-11*	-11*	-11*	-11*	-11*	-12*	-12*	-12*	-12*	-12*	-13*	-13*	-13*	-13*	-14*
-9	-0	-0	8	8	8	9	10	11	12	13	15	16	17	19	20	22	23	25	27	29	31	33	35	38	40
3*	-0*	-15*	-11*	-10*	-9*	-9*	-9*	-9*	-9*	-9*	-9*	-9*	-9*	-9*	-9*	-9*	-10*	-10*	-10*	-10*	-10*	-11*	-11*	-11*	-12*
-8	-0	3	4	5	6	7	8	9	11	12	13	14	16	17	19	20	22	24	25	27	29	31	34	36	38
3*	6*	-2*	-4*	-5*	-5*	-6*	-6*	-6*	-6*	-7*	-7*	-7*	-7*	-7*	-7*	-8*	-8*	-8*	-8*	-8*	-9*	-9*	-9*	-9*	-10*
-7	-2	0	1	3	4	5	7	8	9	10	12	13	14	16	17	19	20	22	24	26	28	30	32	34	37
3*	19*	2*	-1*	-2*	-3*	-4*	-4*	-4*	-5*	-5*	-5*	-5*	-5*	-6*	-6*	-6*	-6*	-6*	-6*	-7*	-7*	-7*	-7*	-8*	-8*
-6	-5	-1	0	1	3	4	5	7	8	9	10	12	13	14	16	17	19	21	23	24	26	29	31	33	35
3*	16*	3*	0*	-1*	-2*	-2*	-3*	-3*	-3*	-3*	-4*	-4*	-4*	-4*	-4*	-4*	-5*	-5*	-5*	-5*	-5*	-6*	-6*	-6*	-6*
-5	-5	-2	0	1	2	3	5	6	7	8	9	11	12	13	15	16	18	20	21	23	25	27	29	32	34
3*	8*	1*	0*	0*	-1*	-2*	-2*	-2*	-2*	-2*	-2*	-3*	-3*	-3*	-3*	-3*	-3*	-3*	-4*	-4*	-4*	-4*	-4*	-4*	-5*
-4	-4	-2	0	0	2	3	4	5	6	7	8	10	11	12	14	15	17	18	20	22	24	26	28	31	33
3*	1*	0*	0*	0*	-1*	-1*	-1*	-1*	-1*	-1*	-2*	-2*	-2*	-2*	-2*	-2*	-2*	-2*	-2*	-3*	-3*	-3*	-3*	-3*	-3*
-3	-2	-1	0	1	2	3	4	5	6	7	8	9	10	11	13	14	16	18	19	21	23	25	27	30	32
3*	0*	0*	0*	0*	0*	0*	0*	0*	-1*	-1*	-1*	-1*	-1*	-1*	-1*	-1*	-1*	-1*	-1*	-1*	-1*	-2*	-2*	-2*	-2*
-2	0	0	0	1	2	3	3	4	5	6	7	8	9	11	12	14	15	17	19	20	22	25	27	29	31
3*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*
-1	0	1	1	1	2	2	3	4	5	5	6	8	9	10	11	13	15	16	18	20	22	24	26	28	31
3*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*
0	0	0	1	1	1	2	2	3	4	5	6	7	8	9	11	12	14	16	17	19	21	23	26	28	30
3*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	1*	1*	1*	1*	1*	1*	1*	1*
1	0	0	0	0	0	1	2	3	3	4	5	7	8	9	10	12	14	15	17	19	21	23	25	27	30
3*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	1*	1*	1*	1*	1*	1*	1*	1*	1*	2*	2*	2*	2*	2*	2*
2	0	0	0	0	0	0	1	2	3	4	5	6	7	9	10	12	13	15	17	19	21	23	25	27	29
3*	0*	0*	0*	0*	0*	0*	0*	0*	1*	1*	1*	1*	1*	2*	2*	2*	2*	2*	2*	3*	3*	3*	3*	3*	3*
3	0	0	0	0	0	0	1	2	2	3	5	6	7	8	10	11	13	15	16	18	20	22	25	27	29
3*	-3*	-1*	0*	0*	0*	0*	0*	0*	1*	1*	1*	2*	2*	2*	2*	3*	3*	3*	3*	3*	4*	4*	4*	4*	4*
4	-1	-1	-1	-1	0	0	0	1	2	3	4	6	7	8	10	11	13	15	16	18	20	22	25	27	29
3*	-11*	-3*	-1*	-1*	0*	0*	0*	1*	1*	1*	2*	2*	2*	3*	3*	3*	4*	4*	4*	4*	5*	5*	5*	5*	6*
5	-3	-2	-1	-1	-1	0	0	1	2	3	4	5	7	8	10	11	13	15	16	18	20	22	25	27	29
3*	-26*	-7*	-3*	-1*	0*	0*	0*	1*	1*	2*	2*	3*	3*	3*	4*	4*	4*	5*	5*	5*	6*	6*	6*	7*	7*
6	-6	-3	-2	-2	-1	0	0	1	2	3	4	5	7	8	10	11	13	15	17	19	21	23	25	27	30
3*	-48*	-12*	-5*	-2*	-1*	0*	0*	1*	2*	2*	3*	3*	4*	4*	5*	5*	5*	6*	6*	6*	7*	7*	8*	8*	8*
7	-9	-5	-3	-2	-1	0	0	1	2	3	4	6	7	8	10	12	13	15	17	19	21	23	25	27	30
3*	-0*	-18*	-7*	-3*	-1*	0*	0*	1*	2*	3*	3*	4*	4*	5*	5*	6*	6*	7*	7*	8*	8*	8*	9*	9*	10*
8	-0	-6	-4	-2	-1	0	0	1	2	3	5	6	7	9	10	12	14	15	17	19	21	23	26	28	30
3*	-0*	-0*	-9*	-4*	-1*	0*	1*	2*	3*	4*	4*	5*	5*	6*	6*	7*	7*	8*	8*	9*	9*	10*	10*	11*	11*
9	-0	-0	-4	-2	-1	0	0	1	2	4	5	6	8	9	11	12	14	16	18	20	22	24	26	29	31

TABLE 4. X- AND Y-COMPONENT ERRORS DUE TO A 1-MILLISECOND ERROR IN ARRIVAL TIME AT MICROPHONE 4

WEIGHTED RANGE SOLUTION TO EVAL TGT LOCN ERROR XFER FCNS

BL	IP	ID	M	N	DXY	UP	SIN	ZZ	V1	V2	V3	TE
4.00	4	8	-9	25	1.000	1.00	5	0.0	0.00	0.00	0.00	10.00

4+	-0+	-0+	9+	4+	1+	0+	-1+	-2+	-3+	-4+	-4+	-5+	-5+	-6+	-6+	-7+	-7+	-8+	-8+	-9+	-9+	-10+	-10+	-11+	-11+
-9	-0	-0	-4	-2	-1	0	0	1	2	4	5	6	8	9	11	12	14	16	18	20	22	24	26	29	31
4+	-0+	18+	7+	3+	1+	0+	0+	-1+	-2+	-3+	-3+	-4+	-4+	-5+	-5+	-6+	-6+	-7+	-7+	-8+	-8+	-8+	-9+	-9+	-10+
-8	-0	-6	-4	-2	-1	0	0	1	2	3	4	6	7	9	10	12	14	15	17	19	21	23	26	28	30
4+	48+	12+	5+	2+	1+	0+	0+	-1+	-2+	-2+	-3+	-3+	-4+	-4+	-5+	-5+	-5+	-6+	-6+	-6+	-7+	-7+	-8+	-8+	-8+
-7	-9	-5	-3	-2	-1	0	0	1	2	3	4	6	7	8	10	12	13	15	17	19	21	23	25	27	30
4+	26+	7+	3+	1+	0+	0+	0+	-1+	-1+	-2+	-2+	-3+	-3+	-3+	-4+	-4+	-4+	-5+	-5+	-5+	-6+	-6+	-6+	-7+	-7+
-6	-6	-3	-2	-2	-1	0	0	1	2	3	4	5	7	8	10	11	13	15	17	19	21	23	25	27	30
4+	11+	3+	1+	1+	0+	0+	0+	-1+	-1+	-1+	-2+	-2+	-2+	-3+	-3+	-3+	-4+	-4+	-4+	-4+	-5+	-5+	-5+	-5+	-6+
-5	-3	-2	-1	-1	-1	0	0	1	2	3	4	5	7	8	10	11	13	15	16	18	20	22	25	27	29
4+	3+	1+	0+	0+	0+	0+	0+	0+	-1+	-1+	-1+	-2+	-2+	-2+	-2+	-3+	-3+	-3+	-3+	-3+	-4+	-4+	-4+	-4+	-4+
-4	-1	-1	-1	-1	0	0	0	1	2	3	4	6	7	8	10	11	13	15	16	18	20	22	25	27	29
4+	0+	0+	0+	0+	0+	0+	0+	0+	-1+	-1+	-1+	-1+	-1+	-2+	-2+	-2+	-2+	-2+	-2+	-3+	-3+	-3+	-3+	-3+	-3+
-3	0	0	0	0	0	0	1	2	2	3	5	6	7	8	10	11	13	15	16	18	20	22	25	27	29
4+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+	-1+	-1+	-1+	-1+	-1+	-1+	-1+	-1+	-1+	-2+	-2+	-2+	-2+	-2+	-2+
-2	0	0	0	0	0	0	1	2	3	4	5	6	7	9	10	12	13	15	17	19	21	23	25	27	29
4+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+	-1+	-1+	-1+	-1+	-1+	-1+	-1+	-1+
-1	0	0	0	0	0	1	2	3	3	4	5	7	8	9	10	12	14	15	17	19	21	23	25	27	30
4+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+
0	0	0	1	1	1	2	2	3	4	5	6	7	8	9	11	12	14	16	17	19	21	23	26	28	30
4+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+
1	0	1	1	1	2	2	3	4	5	5	6	8	9	10	11	13	15	16	18	20	22	24	26	28	31
4+	0+	0+	0+	0+	0+	0+	0+	0+	1+	1+	1+	1+	1+	1+	1+	1+	1+	1+	1+	1+	1+	2+	2+	2+	2+
2	0	0	0	1	2	3	3	4	5	6	7	8	9	11	12	14	15	17	19	20	22	25	27	29	31
4+	-1+	0+	0+	0+	1+	1+	1+	1+	1+	1+	2+	2+	2+	2+	2+	2+	2+	2+	2+	3+	3+	3+	3+	3+	3+
3	-2	-1	0	1	2	3	4	5	6	7	8	9	10	11	13	14	16	18	19	21	23	25	27	30	32
4+	-8+	-1+	0+	0+	1+	2+	2+	2+	2+	2+	2+	3+	3+	3+	3+	3+	3+	3+	4+	4+	4+	4+	4+	4+	5+
4	-4	-2	0	0	2	3	4	5	6	7	8	10	11	12	14	15	17	18	20	22	24	26	28	31	33
4+	-16+	-3+	0+	1+	2+	2+	3+	3+	3+	3+	4+	4+	4+	4+	4+	4+	5+	5+	5+	5+	5+	6+	6+	6+	6+
5	-5	-2	0	1	2	3	5	6	7	8	9	11	12	13	15	16	18	20	21	23	25	27	29	32	34
4+	-19+	-2+	1+	2+	3+	4+	4+	4+	5+	5+	5+	5+	5+	6+	6+	6+	6+	6+	6+	7+	7+	7+	7+	8+	8+
6	-5	-1	0	1	3	4	5	7	8	9	10	12	13	14	16	17	19	21	23	24	26	29	31	33	35
4+	-6+	2+	4+	5+	5+	6+	6+	6+	6+	7+	7+	7+	7+	7+	7+	8+	8+	8+	8+	8+	9+	9+	9+	9+	10+
7	-2	0	1	3	4	5	7	8	9	10	12	13	14	16	17	19	20	22	24	26	28	30	32	34	37
4+	-0+	15+	11+	10+	9+	9+	9+	9+	9+	9+	9+	9+	9+	9+	9+	9+	10+	10+	10+	10+	10+	11+	11+	11+	12+
8	-0	3	4	5	6	7	8	9	11	12	13	14	16	17	19	20	22	24	25	27	29	31	34	36	38
4+	-0+	-0+	23+	17+	15+	13+	12+	12+	12+	11+	11+	11+	11+	11+	11+	12+	12+	12+	12+	12+	13+	13+	13+	13+	14+
9	-0	-0	8	8	8	9	10	11	12	13	15	16	17	19	20	22	23	25	27	29	31	33	35	38	40

TABLE 5. X- AND Y-COMPONENT ERRORS DUE TO A 1-MILLISECOND ERROR IN ARRIVAL TIME AT MICROPHONE 5

WEIGHTED RANGE SOLUTION TO EVAL TGT LOCN ERROR XFER FCNS

BL	IP	ID	M	N	DXY	UP	IN	ZZ	V1	V2	V3	TE
4.00	5	8	-9	25	1.000	1.00	5	0.0	0.00	0.00	0.00	10.00

5*	-0*	-0*	17*	10*	7*	6*	5*	4*	3*	3*	2*	2*	1*	1*	1*	0*	0*	0*	0*	0*	0*	0*	0*	-1*	-1*
-9	-0	-0	-7	-6	-5	-5	-5	-4	-4	-4	-4	-4	-3	-3	-3	-3	-2	-2	-1	-1	-1	0	0	0	1
5*	-0*	20*	10*	7*	5*	4*	3*	3*	2*	2*	1*	1*	1*	1*	0*	0*	0*	0*	0*	0*	0*	0*	0*	-1*	-1*
-8	-0	-6	-5	-4	-4	-4	-4	-4	-4	-3	-3	-3	-3	-3	-2	-2	-2	-1	-1	0	0	0	0	1	1
5*	38*	11*	6*	4*	3*	2*	2*	2*	1*	1*	1*	1*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	-1*	-1*	-1*
-7	-7	-4	-3	-3	-3	-3	-3	-3	-3	-3	-3	-3	-2	-2	-2	-1	-1	-1	0	0	0	0	1	1	2
5*	16*	5*	3*	2*	2*	1*	1*	1*	1*	1*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	-1*	-1*	-1*	-1*
-6	-4	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-1	-1	-1	0	0	0	0	1	1	2	2
5*	5*	2*	1*	1*	1*	1*	1*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	-1*	-1*	-1*	-1*
-5	-1	-1	-1	-1	-1	-2	-2	-2	-2	-2	-2	-1	-1	-1	-1	0	0	0	0	0	1	1	2	2	3
5*	1*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	-1*	-1*	-1*	-1*	-1*
-4	0	0	0	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	0	0	0	0	0	0	1	1	2	2	3	4
5*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	-1*	-1*	-1*	-1*	-1*
-3	0	0	0	0	-1	-1	-1	-1	-1	-1	-1	0	0	0	0	0	0	1	1	2	2	3	3	4	4
5*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	-1*	-1*	-1*	-1*
-2	0	0	0	0	-1	-1	-1	0	0	0	0	0	0	0	0	1	1	1	2	2	3	3	4	4	5
5*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*
-1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	2	2	3	3	4	4	5	5	6
5*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*
0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	2	2	3	3	3	4	4	5	5	6	7
5*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*
1	0	0	0	0	0	0	1	1	1	1	1	2	2	2	3	3	3	4	4	5	5	6	6	7	7
5*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*
2	1	2	2	2	2	2	2	2	2	2	3	3	3	3	4	4	4	5	5	6	6	7	7	8	8
5*	4*	2*	2*	1*	1*	1*	1*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*
3	3	4	4	4	4	3	3	3	3	4	4	4	4	4	5	5	5	6	6	7	7	8	8	9	9
5*	22*	8*	5*	4*	3*	2*	2*	2*	1*	1*	1*	1*	1*	1*	1*	1*	1*	1*	1*	1*	0*	0*	0*	0*	0*
4	9	7	6	6	6	5	5	5	5	5	5	5	5	6	6	6	7	7	7	8	8	9	9	10	10
5*	68*	21*	12*	8*	6*	5*	4*	3*	3*	2*	2*	2*	2*	2*	1*	1*	1*	1*	1*	1*	1*	1*	1*	1*	1*
5	20	12	10	9	8	7	7	7	7	6	7	7	7	7	7	7	8	8	9	9	9	10	10	11	11
5*	156*	43*	22*	14*	10*	8*	6*	5*	5*	4*	3*	3*	3*	3*	2*	2*	2*	2*	2*	2*	2*	2*	2*	2*	2*
6	34	18	14	12	11	10	9	9	8	8	8	8	8	8	9	9	9	9	10	10	11	11	12	12	13
5*	294*	77*	38*	23*	16*	12*	10*	8*	7*	6*	5*	5*	4*	4*	4*	4*	3*	3*	3*	3*	3*	3*	3*	3*	3*
7	51	27	19	16	14	12	12	11	10	10	10	10	10	10	10	10	11	11	11	12	12	12	13	13	14
5*	-0*	125*	59*	36*	25*	18*	14*	12*	10*	9*	8*	7*	6*	6*	5*	5*	5*	4*	4*	4*	4*	4*	4*	4*	4*
8	-0	36	26	20	18	16	14	13	13	12	12	12	12	12	12	12	12	12	13	13	13	14	14	15	15
5*	-0*	-0*	87*	52*	35*	26*	20*	16*	14*	12*	10*	9*	8*	8*	7*	7*	6*	6*	6*	5*	5*	5*	5*	5*	5*
9	-0	-0	33	26	22	19	17	16	15	15	14	14	14	14	14	14	14	14	14	15	15	15	16	16	17

TABLE 6. X- AND Y-COMPONENT ERRORS DUE TO A 1-MILLISECOND ERROR IN ARRIVAL TIME AT MICROPHONE 6

WEIGHTED RANGE SOLUTION TO EVAL TGT LOCN ERROR XFER FCNS

RL	IP	ID	M	N	DXY	UP	IW	ZZ	V1	V2	V3	TE
4.00	6	8	-9	25	1.000	1.00	5	0.0	0.00	0.00	0.00	10.00

6*	-0*	-0*	16*	11*	8*	7*	7*	7*	7*	7*	7*	8*	8*	8*	9*	9*	9*	10*	10*	11*	11*	12*	12*	12*	13*
-9	-0	-0	-6	-6	-5	-6	-6	-7	-8	-9	-11	-12	-13	-15	-17	-19	-21	-23	-25	-27	-30	-32	-35	-38	-41
6*	-0*	16*	8*	6*	5*	5*	5*	5*	5*	5*	6*	6*	6*	7*	7*	7*	8*	8*	8*	9*	9*	10*	10*	11*	11*
-8	-0	-5	-4	-4	-4	-4	-5	-6	-7	-8	-9	-11	-12	-14	-16	-17	-19	-22	-24	-26	-29	-31	-34	-37	-40
6*	25*	7*	4*	3*	3*	3*	3*	3*	4*	4*	4*	4*	5*	5*	6*	6*	6*	7*	7*	7*	8*	8*	8*	9*	9*
-7	-4	-2	-2	-2	-3	-3	-4	-5	-6	-7	-8	-10	-11	-13	-15	-17	-19	-21	-23	-25	-28	-30	-33	-36	-39
6*	9*	3*	2*	1*	1*	2*	2*	2*	2*	3*	3*	3*	4*	4*	4*	5*	5*	5*	6*	6*	6*	6*	7*	7*	7*
-6	-2	-1	-1	-1	-2	-2	-3	-4	-5	-6	-8	-9	-10	-12	-14	-16	-18	-20	-22	-25	-27	-30	-32	-35	-38
6*	2*	1*	0*	0*	1*	1*	1*	1*	2*	2*	2*	2*	3*	3*	3*	3*	4*	4*	4*	4*	5*	5*	5*	6*	6*
-5	0	0	0	-1	-1	-2	-3	-3	-5	-6	-7	-8	-10	-12	-13	-15	-17	-19	-22	-24	-26	-29	-32	-35	-38
6*	0*	0*	0*	0*	0*	0*	1*	1*	1*	1*	1*	2*	2*	2*	2*	2*	3*	3*	3*	3*	3*	4*	4*	4*	4*
-4	0	0	0	0	-1	-1	-2	-3	-4	-5	-7	-8	-10	-11	-13	-15	-17	-19	-21	-24	-26	-29	-31	-34	-37
6*	0*	0*	0*	0*	0*	0*	0*	0*	0*	1*	1*	1*	1*	1*	1*	1*	2*	2*	2*	2*	2*	2*	2*	3*	3*
-3	0	0	0	0	-1	-1	-2	-3	-4	-5	-6	-8	-9	-11	-13	-15	-17	-19	-21	-23	-26	-28	-31	-34	-37
6*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	1*	1*	1*	1*	1*	1*	1*	1*	1*	1*
-2	0	0	0	0	-1	-1	-2	-3	-4	-5	-6	-8	-9	-11	-13	-15	-17	-19	-21	-23	-26	-28	-31	-34	-37
6*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*
-1	0	0	0	0	-1	-1	-2	-3	-4	-5	-7	-8	-10	-11	-13	-15	-17	-19	-21	-23	-26	-29	-31	-34	-37
6*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	-1*	-1*	-1*	-1*	-1*
0	0	0	0	-1	-1	-2	-3	-3	-5	-6	-7	-8	-10	-11	-13	-15	-17	-19	-21	-24	-26	-29	-32	-34	-37
6*	0*	0*	0*	0*	0*	0*	0*	0*	-1*	-1*	-1*	-1*	-1*	-1*	-1*	-1*	-1*	-1*	-2*	-2*	-2*	-2*	-2*	-2*	-2*
1	0	0	-1	-1	-2	-2	-3	-4	-5	-6	-7	-9	-10	-12	-14	-16	-18	-20	-22	-24	-27	-29	-32	-35	-38
6*	0*	0*	0*	-1*	-1*	-1*	-1*	-1*	-1*	-1*	-2*	-2*	-2*	-2*	-2*	-2*	-2*	-3*	-3*	-3*	-3*	-3*	-3*	-4*	-4*
2	0	-1	-1	-2	-2	-3	-4	-5	-6	-7	-8	-10	-11	-13	-14	-16	-18	-20	-23	-25	-27	-30	-33	-36	-38
6*	-1*	-1*	-1*	-2*	-2*	-2*	-2*	-2*	-2*	-2*	-3*	-3*	-3*	-3*	-3*	-4*	-4*	-4*	-4*	-4*	-5*	-5*	-5*	-5*	-5*
3	0	-1	-2	-3	-3	-4	-5	-6	-7	-8	-9	-10	-12	-14	-15	-17	-19	-21	-23	-26	-28	-31	-34	-36	-39
6*	-0*	-4*	-3*	-3*	-3*	-3*	-3*	-3*	-3*	-4*	-4*	-4*	-4*	-4*	-5*	-5*	-5*	-5*	-6*	-6*	-6*	-6*	-7*	-7*	-7*
4	-2	-2	-3	-4	-4	-5	-6	-7	-8	-9	-10	-11	-13	-15	-16	-18	-20	-22	-24	-27	-29	-32	-35	-37	-40
6*	-31*	-11*	-7*	-6*	-6*	-5*	-5*	-5*	-5*	-5*	-5*	-6*	-6*	-6*	-6*	-6*	-7*	-7*	-7*	-8*	-8*	-8*	-9*	-9*	-9*
5	-7	-5	-5	-5	-6	-6	-7	-8	-9	-10	-11	-13	-14	-16	-18	-19	-21	-24	-26	-28	-31	-33	-36	-39	-42
6*	-81*	-25*	-14*	-11*	-9*	-8*	-8*	-7*	-7*	-7*	-7*	-7*	-8*	-8*	-8*	-8*	-9*	-9*	-9*	-9*	-10*	-10*	-10*	-11*	-11*
6	-15	-9	-8	-7	-8	-8	-9	-10	-11	-12	-13	-14	-16	-17	-19	-21	-23	-25	-27	-30	-32	-35	-37	-40	-43
6*	-168*	-49*	-26*	-18*	-14*	-12*	-11*	-10*	-10*	-10*	-10*	-10*	-10*	-10*	-10*	-10*	-11*	-11*	-11*	-12*	-12*	-12*	-13*	-13*	-13*
7	-25	-14	-11	-10	-10	-11	-11	-12	-13	-14	-15	-16	-18	-19	-21	-23	-25	-27	-29	-31	-34	-36	-39	-42	-45
6*	-0*	-85*	-43*	-29*	-22*	-18*	-16*	-14*	-14*	-13*	-13*	-13*	-13*	-13*	-13*	-13*	-13*	-13*	-14*	-14*	-14*	-15*	-15*	-15*	-16*
8	-0	-22	-16	-14	-14	-13	-14	-14	-15	-16	-17	-18	-20	-21	-23	-25	-27	-29	-31	-33	-36	-38	-41	-44	-47
6*	-0*	-0*	-68*	-43*	-32*	-26*	-22*	-20*	-18*	-17*	-16*	-16*	-16*	-16*	-16*	-16*	-16*	-16*	-16*	-17*	-17*	-17*	-18*	-18*	-18*
9	-0	-0	-23	-19	-18	-17	-17	-17	-18	-18	-19	-21	-22	-23	-25	-27	-29	-31	-33	-35	-38	-40	-43	-46	-49

TABLE 7. X- AND Y-COMPONENT ERRORS DUE TO A 3-MILLISECOND ERROR IN ARRIVAL TIME AT MICROPHONE 1

WEIGHTED RANGE SOLUTION TO EVAL TAT LOCN ERROR XFER FCNS

RL	IP	TO	M	N	DXY	UP	IN	ZZ	V1	V2	V3	TE
4.00	1	8	-9	25	1.000	3.00	5	0.0	0.00	0.00	0.00	10.00

1+	******+	404+	203+	130+	96+	78+	67+	60+	55+	52+	50+	49+	48+	48+	48+	48+	49+	49+	50+	51+	52+	53+	54+	55+	56+
-9	-156	-92	-69	-58	-54	-52	-51	-92	-54	-56	-59	-63	-67	-71	-76	-81	-87	-93	-100	-107	-114	-121	-129	-138	-147
1+	450+	252+	130+	86+	65+	55+	48+	44+	42+	40+	39+	39+	39+	39+	39+	40+	40+	41+	42+	43+	44+	45+	46+	47+	48+
-8	-111	-65	-50	-44	-42	-41	-42	-43	-46	-48	-52	-56	-60	-64	-69	-75	-81	-87	-93	-100	-107	-115	-123	-132	-140
1+	481+	145+	78+	55+	44+	38+	34+	32+	31+	30+	30+	30+	30+	31+	32+	32+	33+	34+	35+	36+	37+	38+	39+	40+	41+
-7	-73	-44	-35	-32	-32	-32	-34	-36	-39	-42	-45	-49	-54	-58	-63	-69	-75	-81	-88	-94	-102	-110	-118	-126	-135
1+	235+	75+	44+	33+	28+	25+	24+	23+	23+	23+	23+	23+	24+	24+	25+	26+	27+	28+	28+	29+	30+	31+	32+	33+	34+
-6	-43	-27	-24	-23	-24	-26	-28	-30	-33	-36	-40	-44	-48	-53	-58	-64	-70	-76	-83	-90	-97	-105	-113	-121	-130
1+	93+	34+	23+	19+	17+	17+	16+	16+	16+	17+	17+	18+	18+	19+	20+	20+	21+	22+	23+	24+	25+	26+	26+	27+	28+
-5	-21	-15	-15	-16	-18	-20	-22	-25	-28	-31	-35	-30	-44	-49	-54	-59	-65	-71	-78	-85	-93	-100	-108	-117	-126
1+	26+	13+	11+	11+	10+	11+	11+	11+	11+	12+	12+	13+	14+	14+	15+	16+	16+	17+	18+	19+	19+	20+	21+	22+	23+
-4	-8	-8	-10	-12	-14	-16	-18	-21	-24	-27	-31	-35	-40	-45	-50	-55	-61	-68	-74	-81	-89	-97	-105	-113	-122
1+	4+	5+	5+	6+	6+	6+	7+	7+	8+	8+	9+	9+	10+	10+	11+	12+	12+	13+	13+	14+	15+	15+	16+	17+	17+
-3	-2	-4	-7	-9	-11	-13	-15	-18	-21	-24	-28	-32	-37	-42	-47	-52	-58	-65	-71	-78	-86	-93	-102	-110	-119
1+	1+	2+	2+	3+	3+	3+	4+	4+	5+	5+	6+	6+	7+	7+	8+	8+	8+	9+	9+	10+	10+	11+	11+	12+	12+
-2	-1	-3	-5	-6	-8	-10	-12	-15	-18	-22	-25	-30	-34	-39	-44	-50	-56	-62	-69	-76	-83	-91	-99	-107	-116
1+	0+	0+	0+	1+	1+	2+	2+	2+	3+	3+	3+	3+	4+	4+	4+	5+	5+	5+	6+	6+	6+	7+	7+	7+	8+
-1	-1	-2	-3	-4	-6	-8	-10	-13	-16	-20	-23	-27	-32	-37	-42	-48	-54	-60	-67	-74	-81	-89	-97	-105	-114
1+	0+	0+	0+	0+	0+	0+	0+	1+	1+	1+	1+	1+	1+	1+	2+	2+	2+	2+	2+	2+	3+	3+	3+	3+	3+
0	0	0	-1	-3	-4	-6	-9	-11	-15	-18	-22	-26	-30	-35	-41	-46	-52	-59	-65	-72	-80	-87	-96	-104	-113
1+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+
1	0	0	0	-2	-3	-5	-8	-10	-14	-17	-21	-25	-30	-34	-40	-45	-51	-58	-64	-71	-79	-86	-95	-103	-112
1+	0+	0+	0+	0+	0+	0+	-1+	-1+	-1+	-1+	-2+	-2+	-2+	-2+	-2+	-3+	-3+	-3+	-3+	-4+	-4+	-4+	-4+	-5+	-5+
2	0	0	0	-1	-3	-5	-7	-10	-13	-16	-20	-24	-29	-34	-39	-45	-51	-57	-64	-71	-78	-86	-94	-103	-112
1+	0+	0+	0+	0+	0+	-1+	-1+	-2+	-2+	-3+	-3+	-4+	-4+	-5+	-5+	-5+	-6+	-6+	-7+	-7+	-8+	-8+	-8+	-9+	-9+
3	0	0	0	-1	-3	-5	-7	-10	-13	-16	-20	-25	-29	-34	-39	-45	-51	-57	-64	-71	-78	-86	-94	-103	-112
1+	-1+	0+	0+	-1+	-1+	-2+	-3+	-3+	-4+	-5+	-5+	-6+	-6+	-7+	-8+	-8+	-9+	-10+	-10+	-11+	-11+	-12+	-13+	-13+	-14+
4	0	0	-1	-2	-3	-5	-8	-10	-14	-17	-21	-25	-30	-35	-40	-45	-51	-58	-65	-72	-79	-87	-95	-103	-112
1+	-8+	-3+	-2+	-2+	-3+	-4+	-4+	-5+	-6+	-7+	-7+	-8+	-9+	-10+	-11+	-11+	-12+	-13+	-14+	-14+	-15+	-16+	-17+	-18+	-18+
5	-2	-2	-2	-3	-4	-6	-9	-11	-15	-18	-22	-26	-31	-36	-41	-47	-53	-59	-66	-73	-80	-88	-96	-105	-113
1+	-28+	-9+	-6+	-5+	-5+	-6+	-7+	-7+	-8+	-9+	-10+	-11+	-12+	-13+	-14+	-15+	-16+	-17+	-18+	-19+	-19+	-20+	-21+	-22+	-23+
6	-7	-4	-4	-5	-6	-8	-10	-13	-16	-20	-24	-28	-32	-37	-43	-48	-54	-61	-67	-74	-82	-90	-98	-106	-115
1+	-76+	-23+	-13+	-10+	-10+	-10+	-10+	-11+	-12+	-13+	-13+	-14+	-15+	-17+	-18+	-19+	-20+	-21+	-22+	-23+	-24+	-25+	-26+	-27+	-28+
7	-14	-8	-7	-8	-9	-11	-13	-16	-19	-22	-26	-30	-35	-40	-45	-51	-57	-63	-70	-77	-84	-92	-100	-109	-118
1+	-171+	-48+	-26+	-19+	-15+	-15+	-15+	-15+	-16+	-17+	-18+	-19+	-20+	-21+	-22+	-23+	-24+	-25+	-26+	-28+	-29+	-30+	-31+	-33+	-34+
8	-27	-15	-12	-12	-13	-14	-16	-19	-22	-25	-29	-33	-38	-43	-48	-53	-59	-66	-73	-80	-87	-95	-103	-111	-120
1+	-339+	-92+	-48+	-33+	-25+	-23+	-22+	-22+	-22+	-22+	-23+	-24+	-25+	-26+	-27+	-28+	-29+	-30+	-32+	-33+	-34+	-36+	-37+	-38+	-40+
9	-46	-25	-19	-18	-13	-19	-20	-23	-26	-29	-33	-37	-41	-46	-51	-57	-63	-69	-76	-83	-90	-98	-106	-115	-124

TABLE 8. X- AND Y-COMPONENT ERRORS DUE TO A 3-MILLISECOND ERROR IN ARRIVAL TIME AT MICROPHONE 2

WEIGHTED RANGE SOLUTION TO EVAL TGT LOCN ERROR XFER FCNS

RL	IP	IN	M	N	DXY	UP	IM	ZZ	V1	V2	V3	TE
4.00	2	8	-9	25	1.000	3.00	5	0.0	0.00	0.00	0.00	10.00

2*	******	-568*	-283*	-156*	-105*	-78*	-61*	-50*	-42*	-36*	-32*	-28*	-26*	-24*	-22*	-20*	-19*	-18*	-18*	-17*	-16*	-16*	-15*	-15*	-15*
-9	270	144	99	78	66	58	53	49	47	45	43	42	42	41	41	42	42	43	43	44	45	46	47	49	50
2*	******	-380*	-179*	-108*	-75*	-56*	-44*	-36*	-31*	-27*	-23*	-21*	-19*	-18*	-17*	-16*	-15*	-14*	-14*	-13*	-13*	-12*	-12*	-12*	-12*
-8	220	111	78	62	53	48	44	41	39	38	37	36	36	36	36	37	37	38	39	40	41	42	43	44	46
2*	-922*	-236*	-114*	-71*	-50*	-38*	-31*	-25*	-22*	-19*	-17*	-15*	-14*	-13*	-12*	-11*	-11*	-10*	-10*	-10*	-9*	-9*	-9*	-9*	-9*
-7	161	92	59	48	42	38	36	34	32	31	31	31	31	31	31	32	32	33	34	35	36	38	39	40	42
2*	-483*	-132*	-68*	-44*	-32*	-25*	-20*	-17*	-14*	-13*	-11*	-10*	-10*	-9*	-8*	-8*	-8*	-7*	-7*	-7*	-7*	-7*	-6*	-6*	-6*
-6	106	57	43	37	33	30	28	27	26	26	25	25	26	26	27	27	28	29	30	31	33	34	35	37	38
2*	-212*	-64*	-36*	-25*	-19*	-15*	-12*	-10*	-9*	-8*	-7*	-6*	-6*	-6*	-5*	-5*	-5*	-5*	-5*	-4*	-4*	-4*	-4*	-4*	-4*
-5	61	36	30	27	25	23	22	21	21	20	20	21	21	22	22	23	24	25	26	28	29	30	32	33	35
2*	-67*	-26*	-17*	-13*	-10*	-8*	-7*	-6*	-5*	-4*	-4*	-4*	-3*	-3*	-3*	-3*	-3*	-3*	-2*	-2*	-2*	-2*	-2*	-2*	-2*
-4	29	21	20	19	19	17	16	16	16	16	16	16	17	18	19	20	21	22	23	24	25	27	28	30	31
2*	-12*	-8*	-7*	-5*	-4*	-3*	-3*	-2*	-2*	-2*	-2*	-1*	-1*	-1*	-1*	-1*	-1*	-1*	-1*	-1*	-1*	-1*	-1*	-1*	-1*
-3	10	12	13	13	12	11	11	11	11	12	12	13	13	14	15	16	17	18	20	21	22	24	25	27	28
2*	-1*	-1*	-1*	-1*	-1*	-1*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*
-2	3	7	8	7	7	6	7	7	7	8	8	9	10	11	12	13	14	15	16	18	19	21	22	24	25
2*	1*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	1*	1*	1*	1*	1*
-1	1	1	2	2	2	2	3	3	4	5	5	6	7	8	9	10	11	12	14	15	16	18	19	21	23
2*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	1*	1*	1*	1*	1*	1*	1*	1*	1*	1*	1*	1*	2*	2*	2*
0	-1	-1	-1	-1	0	0	0	1	1	2	3	3	4	5	6	7	8	10	11	12	14	15	17	18	20
2*	0*	0*	0*	0*	0*	0*	0*	0*	0*	1*	1*	1*	1*	1*	1*	1*	1*	2*	2*	2*	2*	2*	2*	2*	2*
1	0	0	-1	-2	-2	-2	-1	-1	0	0	0	1	2	3	4	5	6	7	9	10	11	13	14	16	18
2*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	1*	1*	1*	1*	1*	2*	2*	2*	2*	2*	2*	3*	3*	3*
2	0	0	-1	-2	-3	-3	-3	-2	-2	-1	-1	0	0	1	2	3	4	5	6	8	9	10	12	14	15
2*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	1*	1*	1*	2*	2*	2*	2*	2*	3*	3*	3*	3*
3	0	0	-1	-2	-3	-4	-4	-4	-4	-3	-3	-2	-1	0	0	1	2	3	4	5	7	8	10	11	13
2*	-3*	-1*	-1*	-1*	-2*	-1*	-1*	-1*	-1*	0*	0*	0*	0*	0*	1*	1*	1*	2*	2*	2*	3*	3*	3*	3*	4*
4	-1	-1	-2	-3	-4	-5	-5	-5	-5	-5	-4	-4	-3	-2	-1	0	0	1	2	3	5	6	8	9	11
2*	-16*	-6*	-4*	-3*	-3*	-3*	-3*	-2*	-2*	-1*	-1*	0*	0*	0*	0*	0*	1*	1*	2*	2*	2*	3*	3*	3*	4*
5	-5	-4	-4	-4	-5	-6	-6	-7	-7	-6	-6	-5	-5	-4	-3	-2	-1	0	0	2	3	4	6	7	9
2*	-50*	-15*	-9*	-7*	-6*	-5*	-5*	-4*	-3*	-3*	-2*	-2*	-1*	0*	0*	0*	0*	1*	1*	2*	2*	3*	3*	3*	4*
6	-12	-7	-6	-7	-7	-8	-8	-8	-8	-8	-8	-7	-6	-6	-5	-4	-3	-2	-1	0	1	2	4	6	7
2*	-117*	-33*	-18*	-12*	-10*	-8*	-7*	-6*	-5*	-4*	-4*	-3*	-2*	-1*	-1*	0*	0*	0*	1*	1*	2*	2*	3*	3*	4*
7	-23	-13	-10	-10	-9	-10	-10	-10	-10	-10	-9	-9	-8	-7	-7	-6	-5	-4	-2	-1	0	1	2	4	5
2*	-233*	-62*	-32*	-21*	-16*	-13*	-11*	-9*	-8*	-7*	-5*	-5*	-4*	-3*	-2*	-1*	-1*	0*	0*	0*	1*	2*	2*	3*	3*
8	-35	-20	-15	-13	-12	-12	-12	-12	-12	-11	-11	-10	-10	-9	-8	-7	-6	-5	-4	-3	-1	0	0	2	4
2*	-815*	-106*	-51*	-32*	-23*	-18*	-15*	-13*	-11*	-9*	-8*	-7*	-5*	-4*	-3*	-2*	-2*	-1*	0*	0*	0*	1*	2*	2*	3*
9	-57	-29	-21	-18	-16	-15	-15	-14	-14	-13	-13	-12	-12	-11	-10	-9	-8	-7	-6	-4	-3	-2	0	0	2

TABLE 9. X- AND Y-COMPONENT ERRORS DUE TO A 3-MILLISECOND ERROR IN ARRIVAL TIME AT MICROPHONE 3

WEIGHTED RANGE SOLUTION TO EVAL TAT LOCN ERROR XFER FCNS

RL	IP	IN	M	N	DXY	UP	TH	ZZ	V1	V2	V3	TE
4.00	3	8	-9	25	1.000	3.00	5	0.0	0.00	0.00	0.00	10.00

3+	-148+	-103+	-67+	-52+	-44+	-40+	-38+	-37+	-36+	-35+	-35+	-35+	-35+	-35+	-35+	-36+	-36+	-37+	-37+	-38+	-39+	-39+	-40+	-41+	-42+
-9	11	23	23	24	26	28	31	34	38	41	45	49	53	57	62	66	71	76	82	88	94	100	106	113	120
3+	-27+	-42+	-33+	-29+	-28+	-27+	-27+	-27+	-27+	-27+	-27+	-28+	-28+	-28+	-29+	-29+	-30+	-30+	-31+	-32+	-32+	-33+	-34+	-35+	-35+
-8	-2	9	12	15	18	22	25	29	32	36	40	44	48	52	57	61	66	71	77	83	89	95	101	108	115
3+	43+	-6+	-13+	-16+	-17+	-18+	-19+	-20+	-20+	-21+	-21+	-22+	-22+	-22+	-23+	-23+	-24+	-25+	-25+	-26+	-27+	-27+	-28+	-29+	-30+
-7	-12	0	5	9	13	17	21	24	28	32	35	39	43	48	52	57	62	67	72	78	84	90	97	104	111
3+	64+	7+	-3+	-8+	-10+	-12+	-14+	-14+	-15+	-16+	-16+	-17+	-17+	-17+	-18+	-19+	-19+	-20+	-20+	-21+	-22+	-22+	-23+	-23+	-24+
-6	-18	-5	0	5	9	13	17	21	25	28	32	36	40	44	48	53	58	63	68	74	80	86	93	100	107
3+	50+	9+	0+	-4+	-7+	-8+	-9+	-10+	-11+	-11+	-12+	-12+	-13+	-13+	-14+	-14+	-15+	-15+	-16+	-16+	-17+	-17+	-18+	-19+	-19+
-5	-17	-7	-1	3	7	11	15	18	22	25	29	32	36	40	45	49	54	59	65	70	76	83	89	96	103
3+	24+	5+	0+	-2+	-4+	-6+	-6+	-7+	-8+	-8+	-8+	-9+	-9+	-10+	-10+	-10+	-11+	-11+	-12+	-12+	-13+	-13+	-14+	-14+	-15+
-4	-12	-6	-2	2	6	10	13	16	20	23	26	30	34	38	42	46	51	56	62	67	73	79	86	93	100
3+	5+	1+	0+	-2+	-3+	-4+	-4+	-5+	-5+	-5+	-5+	-6+	-6+	-6+	-7+	-7+	-7+	-8+	-8+	-9+	-9+	-9+	-10+	-10+	-10+
-3	-6	-4	-1	2	6	9	12	15	18	21	24	27	31	35	39	44	49	54	59	65	71	77	83	90	97
3+	0+	0+	0+	-1+	-2+	-2+	-2+	-2+	-3+	-3+	-3+	-3+	-3+	-4+	-4+	-4+	-4+	-5+	-5+	-5+	-5+	-6+	-6+	-6+	-6+
-2	-2	-2	1	4	7	9	11	14	16	19	22	25	29	33	37	42	46	51	57	62	68	74	81	88	95
3+	-1+	0+	0+	0+	0+	0+	-1+	-1+	-1+	-1+	-1+	-1+	-1+	-1+	-1+	-1+	-2+	-2+	-2+	-2+	-2+	-2+	-2+	-2+	-2+
-1	1	3	4	5	6	8	10	12	15	17	20	24	27	31	35	40	44	49	55	60	66	72	79	86	93
3+	1+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+
0	1	2	3	4	5	6	8	10	13	16	19	22	26	29	34	38	43	48	53	59	65	71	77	84	91
3+	0+	0+	0+	0+	0+	1+	1+	1+	1+	1+	1+	2+	2+	2+	2+	2+	2+	3+	3+	3+	3+	3+	3+	4+	4+
1	-1	-1	0	0	2	4	6	9	11	14	17	20	24	28	32	37	41	46	52	57	63	69	76	83	90
3+	0+	0+	0+	0+	0+	1+	1+	2+	2+	2+	3+	3+	3+	4+	4+	4+	5+	5+	5+	6+	6+	6+	7+	7+	7+
2	0	-1	-1	-1	0	2	4	7	10	13	16	19	23	27	31	36	40	46	51	56	62	69	75	82	89
3+	-1+	0+	0+	0+	0+	1+	1+	2+	3+	3+	4+	5+	5+	6+	6+	7+	7+	8+	8+	9+	9+	9+	10+	10+	11+
3	-1	-2	-2	-2	-1	0	3	5	8	11	15	18	22	26	30	35	40	45	50	56	62	68	75	81	88
3+	-9+	-3+	-2+	-1+	0+	0+	1+	2+	3+	4+	5+	6+	7+	7+	8+	9+	9+	10+	11+	11+	12+	13+	13+	14+	14+
4	-4	-4	-4	-3	-2	0	2	4	7	11	14	18	21	26	30	35	39	45	50	56	62	68	74	81	88
3+	-33+	-10+	-5+	-3+	-1+	0+	1+	3+	4+	5+	6+	7+	8+	9+	10+	11+	12+	13+	13+	14+	15+	16+	16+	17+	18+
5	-11	-7	-5	-4	-3	-1	1	4	7	10	13	17	21	25	30	34	39	45	50	56	62	68	75	81	88
3+	-80+	-22+	-10+	-5+	-2+	0+	1+	3+	5+	6+	8+	9+	10+	11+	12+	13+	14+	15+	16+	17+	18+	19+	20+	21+	22+
6	-20	-11	-8	-6	-4	-1	0	3	6	10	13	17	21	25	30	35	40	45	50	56	62	69	75	82	89
3+	-151+	-37+	-16+	-8+	-3+	0+	2+	4+	6+	7+	9+	11+	12+	13+	14+	16+	17+	18+	19+	20+	21+	22+	23+	24+	26+
7	-30	-15	-10	-7	-4	-2	0	3	6	10	14	18	22	26	31	35	40	46	51	57	63	70	76	83	90
3+	-245+	-56+	-23+	-11+	-4+	0+	2+	5+	7+	9+	11+	13+	14+	16+	17+	18+	20+	21+	22+	24+	25+	26+	27+	28+	30+
8	-41	-19	-12	-8	-5	-2	0	4	7	11	14	18	23	27	32	36	42	47	53	58	64	71	77	84	92
3+	-365+	-74+	-28+	-12+	-4+	0+	4+	7+	9+	11+	13+	15+	17+	19+	20+	22+	23+	25+	26+	27+	29+	30+	31+	33+	34+
9	-53	-22	-13	-8	-4	-1	1	5	8	12	16	20	24	28	33	38	43	49	54	60	66	73	79	86	93

TABLE 10. X- AND Y-COMPONENT ERRORS DUE TO A 3-MILLISECOND ERROR IN ARRIVAL TIME AT MICROPHONE 4

WEIGHTED RANGE SOLUTION TO EVAL TGT LOCN ERROR XFER FCNS

RL	IP	IR	M	N	DXY	UP	IW	ZZ	V1	V2	V3	TE
4.00	4	8	-9	25	1.000	3.00	5	0.0	0.00	0.00	0.00	10.00

4+	368+	74+	28+	12+	4+	0+	-4+	-7+	-9+	-11+	-13+	-15+	-17+	-19+	-20+	-22+	-23+	-25+	-26+	-27+	-29+	-30+	-31+	-33+	-38+
-9	-53	-22	-13	-8	-4	-1	1	5	8	12	16	20	24	28	33	38	43	49	54	60	66	73	79	86	93
4+	245+	56+	23+	11+	4+	0+	-2+	-5+	-7+	-9+	-11+	-13+	-14+	-16+	-17+	-18+	-20+	-21+	-22+	-24+	-25+	-26+	-27+	-28+	-30+
-8	-41	-19	-12	-8	-5	-2	0	4	7	11	14	18	23	27	32	36	42	47	53	58	64	71	77	84	92
4+	151+	37+	16+	8+	3+	0+	-2+	-4+	-6+	-7+	-9+	-11+	-12+	-13+	-14+	-16+	-17+	-18+	-19+	-20+	-21+	-22+	-23+	-24+	-26+
-7	-30	-15	-10	-7	-4	-2	0	3	6	10	14	18	22	26	31	35	40	46	51	57	63	70	76	83	90
4+	80+	22+	10+	5+	2+	0+	-1+	-3+	-5+	-6+	-8+	-9+	-10+	-11+	-12+	-13+	-14+	-15+	-16+	-17+	-18+	-19+	-20+	-21+	-22+
-6	-20	-11	-8	-6	-4	-1	0	3	6	10	13	17	21	25	30	35	40	45	50	56	62	69	75	82	89
4+	33+	10+	5+	3+	1+	0+	-1+	-3+	-4+	-5+	-6+	-7+	-8+	-9+	-10+	-11+	-12+	-13+	-13+	-14+	-15+	-16+	-16+	-17+	-18+
-5	-11	-7	-5	-4	-3	-1	1	4	7	10	13	17	21	25	30	34	39	45	50	56	62	68	75	81	88
4+	9+	3+	2+	1+	0+	0+	-1+	-2+	-3+	-4+	-5+	-6+	-7+	-7+	-8+	-9+	-9+	-10+	-11+	-11+	-12+	-13+	-13+	-14+	-14+
-4	-4	-4	-4	-3	-2	0	2	4	7	11	14	18	21	26	30	35	39	45	50	56	62	68	74	81	88
4+	1+	0+	0+	0+	0+	-1+	-1+	-2+	-3+	-3+	-4+	-5+	-5+	-6+	-6+	-7+	-7+	-8+	-8+	-9+	-9+	-9+	-10+	-10+	-11+
-3	-1	-2	-2	-2	-1	0	3	5	8	11	15	18	22	26	30	35	40	45	50	56	62	68	75	81	88
4+	0+	0+	0+	0+	0+	-1+	-1+	-2+	-2+	-2+	-3+	-3+	-3+	-4+	-4+	-4+	-5+	-5+	-5+	-6+	-6+	-6+	-7+	-7+	-7+
-2	0	-1	-1	-1	0	2	4	7	10	13	16	19	23	27	31	36	40	46	51	56	62	69	75	82	89
4+	0+	0+	0+	0+	0+	-1+	-1+	-1+	-1+	-1+	-1+	-2+	-2+	-2+	-2+	-2+	-2+	-3+	-3+	-3+	-3+	-3+	-3+	-4+	-4+
-1	-1	-1	0	0	2	4	6	9	11	14	17	20	24	28	32	37	41	46	52	57	63	69	76	83	90
4+	-1+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+
0	1	2	3	4	5	6	8	10	13	16	19	22	26	29	34	38	43	48	53	59	65	71	77	84	91
4+	1+	0+	0+	0+	0+	0+	1+	1+	1+	1+	1+	1+	1+	1+	1+	1+	2+	2+	2+	2+	2+	2+	2+	2+	2+
1	1	3	4	5	6	8	10	12	15	17	20	24	27	31	35	40	44	49	55	60	66	72	79	86	93
4+	0+	0+	0+	1+	2+	2+	2+	2+	3+	3+	3+	3+	3+	4+	4+	4+	4+	5+	5+	5+	5+	6+	6+	6+	6+
2	-2	-2	1	4	7	9	11	14	16	19	22	25	29	33	37	42	46	51	57	62	68	74	81	88	95
4+	-5+	-1+	0+	2+	3+	4+	4+	5+	5+	5+	5+	6+	6+	6+	7+	7+	7+	8+	8+	9+	9+	9+	10+	10+	10+
3	-6	-4	-1	2	6	9	12	15	18	21	24	27	31	35	39	44	49	54	59	65	71	77	83	90	97
4+	-24+	-5+	0+	2+	4+	6+	6+	7+	8+	8+	8+	9+	9+	10+	10+	10+	11+	11+	12+	12+	13+	13+	14+	14+	15+
4	-12	-6	-2	2	6	10	13	16	20	23	26	30	34	38	42	46	51	56	62	67	73	79	86	93	100
4+	-50+	-9+	0+	4+	7+	8+	9+	10+	11+	11+	12+	12+	13+	13+	14+	14+	15+	15+	16+	16+	17+	17+	18+	19+	19+
5	-17	-7	-1	3	7	11	15	18	22	25	29	32	36	40	45	49	54	59	65	70	76	83	89	96	103
4+	-64+	-7+	3+	8+	10+	12+	14+	14+	15+	16+	16+	17+	17+	17+	18+	19+	19+	20+	20+	21+	22+	22+	23+	23+	24+
6	-18	-5	0	5	9	13	17	21	25	28	32	36	40	44	48	53	58	63	68	74	80	86	93	100	107
4+	-43+	6+	13+	16+	17+	18+	19+	20+	20+	21+	21+	22+	22+	22+	23+	23+	24+	25+	25+	26+	27+	27+	28+	29+	30+
7	-12	0	5	9	13	17	21	24	28	32	35	39	43	48	52	57	62	67	72	78	84	90	97	104	111
4+	27+	42+	33+	29+	28+	27+	27+	27+	27+	27+	27+	28+	28+	28+	29+	29+	30+	30+	31+	32+	32+	33+	34+	35+	35+
8	-2	9	12	15	19	22	25	29	32	36	40	44	48	52	57	61	66	71	77	83	89	95	101	108	115
4+	148+	105+	67+	52+	44+	40+	38+	37+	36+	35+	35+	35+	35+	35+	35+	36+	36+	37+	37+	38+	39+	39+	40+	41+	42+
9	11	23	23	24	25	28	31	34	38	41	45	49	53	57	62	66	71	76	82	88	94	100	106	113	120

TABLE 11. X- AND Y-COMPONENT ERRORS DUE TO A 3-MILLISECOND ERROR IN ARRIVAL TIME AT MICROPHONE 5

WEIGHTED RANGE SOLUTION TO EVAL TGT LOCN ERROR XFER FCNS

RL	IP	IN	M	N	DXY	UP	TN	ZZ	V1	V2	V3	TE
4.00	5	8	-9	25	1.000	3.00	5	0.0	0.00	0.00	0.00	10.00

5+	415+	106+	51+	32+	23+	18+	15+	13+	11+	9+	8+	7+	5+	4+	3+	2+	2+	1+	0+	0+	0+	-1+	-2+	-2+	-3+
-9	-57	-29	-21	-18	-16	-15	-15	-14	-14	-13	-13	-12	-12	-11	-10	-9	-8	-7	-6	-4	-3	-2	0	0	2
5+	233+	62+	32+	21+	16+	13+	11+	9+	8+	7+	5+	5+	4+	3+	2+	1+	1+	0+	0+	0+	-1+	-2+	-2+	-3+	-3+
-8	-38	-20	-15	-13	-12	-12	-12	-12	-12	-11	-11	-10	-10	-9	-8	-7	-6	-5	-4	-3	-1	0	0	2	4
5+	117+	33+	18+	12+	10+	8+	7+	6+	5+	4+	4+	3+	2+	1+	1+	0+	0+	0+	-1+	-1+	-2+	-2+	-3+	-3+	-4+
-7	-23	-13	-10	-10	-9	-10	-10	-10	-10	-10	-9	-9	-8	-7	-7	-6	-5	-4	-2	-1	0	1	2	4	5
5+	50+	15+	9+	7+	6+	5+	5+	4+	3+	3+	2+	2+	1+	0+	0+	0+	0+	-1+	-1+	-2+	-2+	-3+	-3+	-3+	-4+
-6	-12	-7	-6	-7	-7	-8	-8	-8	-8	-8	-8	-7	-6	-6	-5	-4	-3	-2	-1	0	1	2	4	6	7
5+	16+	6+	4+	3+	3+	3+	3+	2+	2+	1+	1+	0+	0+	0+	0+	0+	-1+	-1+	-2+	-2+	-2+	-3+	-3+	-3+	-4+
-5	-5	-4	-4	-4	-5	-6	-6	-7	-7	-6	-6	-5	-5	-4	-3	-2	-1	0	0	2	3	4	6	7	9
5+	3+	1+	1+	1+	2+	1+	1+	1+	1+	0+	0+	0+	0+	0+	-1+	-1+	-1+	-2+	-2+	-2+	-3+	-3+	-3+	-3+	-4+
-4	-1	-1	-2	-3	-4	-5	-5	-5	-5	-5	-4	-4	-3	-2	-1	0	0	1	2	3	5	6	8	9	11
5+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+	-1+	-1+	-1+	-2+	-2+	-2+	-2+	-2+	-3+	-3+	-3+	-3+
-3	0	0	-1	-2	-3	-4	-4	-4	-4	-3	-3	-2	-1	0	0	1	2	3	4	5	7	8	10	11	13
5+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+	-1+	-1+	-1+	-1+	-1+	-2+	-2+	-2+	-2+	-2+	-2+	-3+	-3+	-3+
-2	0	0	-1	-2	-3	-3	-3	-2	-2	-1	-1	0	0	1	2	3	4	5	6	8	9	10	12	14	15
5+	0+	0+	0+	0+	0+	0+	0+	0+	0+	-1+	-1+	-1+	-1+	-1+	-1+	-1+	-1+	-2+	-2+	-2+	-2+	-2+	-2+	-2+	-2+
-1	0	0	-1	-2	-2	-2	-1	-1	0	0	0	1	2	3	4	5	6	7	9	10	11	13	14	16	18
5+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+	-1+	-1+	-1+	-1+	-1+	-1+	-1+	-1+	-1+	-1+	-1+	-1+	-2+	-2+	-2+
0	-1	-1	-1	-1	0	0	0	1	1	2	3	3	4	5	6	7	8	10	11	12	14	15	17	18	20
5+	-1+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+	-1+	-1+	-1+	-1+	-1+	-1+
1	1	1	2	2	2	2	3	3	4	5	5	6	7	8	9	10	11	12	14	15	16	18	19	21	23
5+	1+	1+	1+	1+	1+	1+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+
2	3	7	8	7	7	6	7	7	7	8	8	9	10	11	12	13	14	15	16	18	19	21	22	24	25
5+	12+	8+	7+	5+	4+	3+	3+	2+	2+	2+	2+	1+	1+	1+	1+	1+	1+	1+	1+	1+	1+	1+	1+	1+	1+
3	10	12	13	13	12	11	11	11	11	12	12	13	13	14	15	16	17	18	20	21	22	24	25	27	28
5+	67+	26+	17+	13+	10+	8+	7+	6+	5+	4+	4+	4+	3+	3+	3+	3+	3+	3+	2+	2+	2+	2+	2+	2+	2+
4	29	21	20	19	18	17	16	16	16	16	16	16	17	18	19	20	21	22	23	24	25	27	28	30	31
5+	212+	64+	36+	25+	19+	15+	12+	10+	9+	8+	7+	6+	6+	6+	5+	5+	5+	5+	5+	4+	4+	4+	4+	4+	4+
5	61	36	30	27	25	23	22	21	21	20	20	21	21	22	22	23	24	25	26	28	29	30	32	33	35
5+	485+	132+	68+	44+	32+	25+	20+	17+	14+	13+	11+	10+	10+	9+	8+	8+	8+	7+	7+	7+	7+	7+	6+	6+	6+
6	106	57	43	37	33	30	28	27	26	26	25	25	26	26	27	27	28	29	30	31	33	34	35	37	38
5+	922+	236+	114+	71+	50+	38+	31+	25+	22+	19+	17+	15+	14+	13+	12+	11+	11+	10+	10+	10+	9+	9+	9+	9+	9+
7	161	82	59	48	42	38	36	34	32	31	31	31	31	31	31	32	32	33	34	35	36	38	39	40	42
5+	*****	380+	179+	108+	75+	56+	44+	36+	31+	27+	23+	21+	19+	18+	17+	16+	15+	14+	14+	13+	13+	12+	12+	12+	12+
8	220	111	78	62	53	48	44	41	39	38	37	36	36	36	36	37	37	38	39	40	41	42	43	44	46
5+	*****	568+	263+	156+	105+	78+	61+	50+	42+	36+	32+	28+	26+	24+	22+	20+	19+	18+	18+	17+	16+	16+	15+	15+	15+
9	270	144	99	78	66	58	53	49	47	45	43	42	42	41	41	42	42	43	43	44	45	46	47	49	50

TABLE 12. X- AND Y-COMPONENT ERRORS DUE TO A 3-MILLISECOND ERROR IN ARRIVAL TIME AT MICROPHONE 6

WEIGHTED RANGE SOLUTION TO EVAL TGT LOCN ERROR XFER FCNS

RL	IP	IN	M	N	DXY	UP	IW	ZZ	V1	V2	V3	TE
4.00	6	8	-9	25	1.000	3.00	5	0.0	0.00	0.00	0.00	10.00

6+	139+	92+	48+	33+	25+	21+	22+	22+	22+	22+	23+	24+	25+	26+	27+	28+	29+	30+	32+	33+	34+	36+	37+	38+	40+
-9	-46	-25	-19	-18	-18	-19	-20	-23	-26	-29	-33	-37	-41	-46	-51	-57	-63	-69	-76	-83	-90	-98	-106	-115	-124
6+	171+	45+	26+	19+	16+	15+	15+	15+	16+	17+	18+	19+	20+	21+	22+	23+	24+	25+	26+	28+	29+	30+	31+	33+	34+
-8	-27	-15	-12	-12	-13	-14	-16	-19	-22	-25	-29	-33	-38	-43	-48	-53	-59	-66	-73	-80	-87	-95	-103	-111	-120
6+	76+	23+	13+	10+	10+	10+	10+	11+	12+	13+	13+	14+	15+	17+	18+	19+	20+	21+	22+	23+	24+	25+	26+	27+	28+
-7	-14	-8	-7	-8	-9	-11	-13	-16	-19	-22	-26	-30	-35	-40	-45	-51	-57	-63	-70	-77	-84	-92	-100	-109	-118
6+	28+	9+	6+	5+	5+	6+	7+	7+	8+	9+	10+	11+	12+	13+	14+	15+	16+	17+	18+	19+	19+	20+	21+	22+	23+
-6	-7	-4	-4	-5	-6	-8	-10	-13	-16	-20	-24	-28	-32	-37	-43	-48	-54	-61	-67	-74	-82	-90	-98	-106	-115
6+	8+	3+	2+	2+	3+	4+	4+	5+	6+	7+	7+	8+	9+	10+	11+	11+	12+	13+	14+	14+	15+	16+	17+	18+	18+
-5	-2	-2	-2	-3	-4	-6	-9	-11	-15	-18	-22	-26	-31	-36	-41	-47	-53	-59	-66	-73	-80	-88	-96	-105	-113
6+	1+	0+	0+	1+	1+	2+	3+	3+	4+	5+	5+	6+	6+	7+	8+	8+	9+	10+	10+	11+	11+	12+	13+	13+	14+
-4	0	0	-1	-2	-3	-5	-8	-10	-14	-17	-21	-25	-30	-35	-40	-45	-51	-58	-65	-72	-79	-87	-95	-103	-112
6+	0+	0+	0+	0+	0+	1+	1+	2+	2+	3+	3+	4+	4+	5+	5+	5+	6+	6+	7+	7+	8+	8+	8+	9+	9+
-3	0	0	0	-1	-3	-5	-7	-10	-13	-16	-20	-25	-29	-34	-39	-45	-51	-57	-64	-71	-78	-86	-94	-103	-112
6+	0+	0+	0+	0+	0+	0+	1+	1+	1+	1+	2+	2+	2+	2+	2+	3+	3+	3+	3+	4+	4+	4+	4+	5+	5+
-2	0	0	0	-1	-3	-5	-7	-10	-13	-16	-20	-24	-29	-34	-39	-45	-51	-57	-64	-71	-78	-86	-94	-103	-112
6+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+
-1	0	0	0	-2	-3	-5	-8	-10	-14	-17	-21	-25	-30	-34	-40	-45	-51	-58	-64	-71	-79	-86	-95	-103	-112
6+	0+	0+	0+	0+	0+	0+	0+	-1+	-1+	-1+	-1+	-1+	-1+	-1+	-2+	-2+	-2+	-2+	-2+	-2+	-3+	-3+	-3+	-3+	-3+
0	0	0	-1	-3	-4	-6	-9	-11	-15	-18	-22	-26	-30	-35	-41	-46	-52	-59	-65	-72	-80	-87	-96	-104	-113
6+	0+	0+	0+	-1+	-1+	-2+	-2+	-2+	-3+	-3+	-3+	-3+	-4+	-4+	-4+	-5+	-5+	-5+	-6+	-6+	-6+	-7+	-7+	-7+	-8+
1	-1	-2	-3	-4	-6	-8	-10	-13	-16	-20	-23	-27	-32	-37	-42	-48	-54	-60	-67	-74	-81	-89	-97	-105	-114
6+	-1+	-2+	-2+	-3+	-3+	-3+	-4+	-4+	-5+	-5+	-6+	-6+	-7+	-7+	-8+	-8+	-8+	-9+	-9+	-10+	-10+	-11+	-11+	-12+	-12+
2	-1	-3	-5	-6	-8	-10	-12	-15	-18	-22	-25	-30	-34	-39	-44	-50	-56	-62	-69	-76	-83	-91	-99	-107	-116
6+	-4+	-5+	-5+	-6+	-6+	-6+	-7+	-7+	-8+	-8+	-9+	-9+	-10+	-10+	-11+	-12+	-12+	-13+	-13+	-14+	-15+	-15+	-16+	-17+	-17+
3	-2	-4	-7	-9	-11	-13	-15	-18	-21	-24	-28	-32	-37	-42	-47	-52	-58	-65	-71	-78	-86	-93	-102	-110	-119
6+	-26+	-13+	-11+	-11+	-10+	-11+	-11+	-11+	-11+	-12+	-12+	-13+	-14+	-14+	-15+	-16+	-16+	-17+	-18+	-19+	-19+	-20+	-21+	-22+	-23+
4	-5	-8	-10	-12	-14	-16	-18	-21	-24	-27	-31	-35	-40	-45	-50	-55	-61	-68	-74	-81	-89	-97	-105	-113	-122
6+	-93+	-34+	-23+	-19+	-17+	-17+	-16+	-16+	-16+	-17+	-17+	-18+	-18+	-19+	-20+	-20+	-21+	-22+	-23+	-24+	-25+	-26+	-26+	-27+	-28+
5	-21	-15	-15	-16	-18	-20	-22	-25	-28	-31	-35	-39	-44	-49	-54	-59	-65	-71	-78	-85	-93	-100	-108	-117	-126
6+	-235+	-75+	-44+	-33+	-28+	-25+	-24+	-23+	-23+	-23+	-23+	-23+	-24+	-24+	-25+	-26+	-27+	-28+	-28+	-29+	-30+	-31+	-32+	-33+	-34+
6	-43	-27	-24	-23	-24	-26	-28	-30	-33	-36	-40	-44	-48	-53	-58	-64	-70	-76	-83	-90	-97	-105	-113	-121	-130
6+	-481+	-145+	-78+	-55+	-44+	-38+	-34+	-32+	-31+	-30+	-30+	-30+	-30+	-31+	-32+	-32+	-33+	-34+	-35+	-36+	-37+	-38+	-39+	-40+	-41+
7	-73	-44	-35	-32	-32	-32	-34	-36	-39	-42	-45	-49	-54	-58	-63	-69	-75	-81	-88	-94	-102	-110	-118	-126	-135
6+	-450+	-252+	-130+	-86+	-66+	-55+	-48+	-44+	-42+	-40+	-39+	-39+	-39+	-39+	-39+	-40+	-40+	-41+	-42+	-43+	-44+	-45+	-46+	-47+	-48+
8	-111	-65	-50	-44	-42	-41	-42	-43	-46	-48	-52	-56	-60	-64	-69	-75	-81	-87	-93	-100	-107	-115	-123	-132	-140
6+	*****+	-404+	-203+	-130+	-96+	-78+	-67+	-60+	-55+	-52+	-50+	-49+	-48+	-48+	-48+	-48+	-49+	-49+	-50+	-51+	-52+	-53+	-54+	-55+	-56+
9	-156	-92	-69	-58	-54	-52	-51	-52	-54	-56	-59	-63	-67	-71	-76	-81	-87	-93	-100	-107	-114	-121	-129	-138	-147

TABLE 13. X- AND Y-COMPONENT ERRORS DUE TO A 10-MILLISECOND ERROR IN ARRIVAL TIME AT MICROPHONE 1

```
WEIGHTED RANGE SOLUTION TO EVAL TOT LOCN ERROR XFER FCNS
BL      IP   ID   M    N   DXY     UP     IN    ZZ    V1    V2    V3    TR
4.00    1    0   -9   25  1.000   10.00   5    0.0   0.00  0.00  0.00  30.00

 1********+ 667+ 423+ 316+ 257+ 221+ 198+ 184+ 174+ 167+ 163+ 161+ 160+ 160+ 161+ 162+ 164+ 167+ 170+ 173+ 176+ 180+ 184+ 188+
-9 -391 -281 -220 -191 -176 -173 -170 -173 -179 -187 -197 -209 -222 -237 -253 -271 -290 -310 -332 -354 -379 -404 -430 -458 -487

 1*****+ 785+ 420+ 283+ 217+ 182+ 161+ 148+ 139+ 134+ 131+ 129+ 129+ 129+ 131+ 132+ 135+ 137+ 140+ 143+ 147+ 150+ 154+ 158+ 162+
-8 -299 -205 -162 -144 -138 -137 -139 -145 -152 -162 -173 -185 -199 -214 -231 -249 -268 -289 -310 -333 -358 -383 -410 -438 -467

 1*****+ 462+ 256+ 181+ 145+ 126+ 115+ 108+ 104+ 102+ 101+ 101+ 102+ 104+ 106+ 108+ 111+ 113+ 117+ 120+ 123+ 127+ 130+ 134+ 137+
-7 -219 -140 -115 -107 -106 -109 -114 -121 -130 -140 -152 -165 -179 -195 -211 -230 -249 -270 -292 -315 -339 -365 -391 -419 -449

 1+ 711+ 244+ 146+ 111+ 94+ 85+ 80+ 78+ 77+ 77+ 77+ 78+ 80+ 82+ 85+ 87+ 90+ 93+ 96+ 99+ 102+ 105+ 109+ 112+ 115+
-6 -137 -89 -78 -78 -81 -86 -93 -101 -110 -121 -133 -147 -161 -177 -194 -213 -232 -253 -275 -298 -323 -348 -375 -403 -433

 1+ 295+ 113+ 77+ 65+ 59+ 56+ 55+ 55+ 55+ 56+ 58+ 60+ 62+ 64+ 66+ 69+ 72+ 74+ 77+ 80+ 83+ 86+ 89+ 92+ 95+
-5 -69 -51 -51 -56 -61 -68 -76 -84 -94 -106 -118 -132 -146 -162 -180 -198 -218 -239 -261 -284 -309 -334 -361 -389 -418

 1+ 85+ 45+ 35+ 37+ 36+ 36+ 37+ 38+ 39+ 41+ 42+ 44+ 46+ 49+ 51+ 53+ 56+ 58+ 61+ 63+ 66+ 68+ 71+ 74+ 76+
-4 -27 -27 -33 -40 -47 -54 -62 -71 -81 -93 -105 -119 -134 -150 -167 -186 -205 -226 -248 -272 -296 -322 -349 -377 -406

 1+ 15+ 16+ 19+ 20+ 21+ 22+ 23+ 25+ 26+ 28+ 30+ 32+ 34+ 36+ 38+ 40+ 42+ 44+ 46+ 48+ 50+ 52+ 54+ 57+ 59+
-3 -7 -15 -23 -30 -36 -43 -51 -60 -70 -82 -94 -108 -123 -139 -157 -175 -195 -216 -238 -261 -286 -312 -339 -367 -396

 1+ 3+ 6+ 9+ 10+ 11+ 13+ 14+ 15+ 17+ 18+ 20+ 21+ 23+ 25+ 26+ 28+ 29+ 31+ 33+ 34+ 36+ 37+ 39+ 41+ 42+
-2 -4 -11 -17 -23 -28 -35 -43 -52 -62 -73 -86 -99 -114 -131 -148 -167 -186 -207 -229 -253 -277 -303 -330 -358 -388

 1+ 0+ 1+ 3+ 4+ 5+ 6+ 7+ 8+ 9+ 11+ 12+ 13+ 14+ 15+ 16+ 17+ 18+ 19+ 20+ 21+ 22+ 23+ 24+ 25+ 27+
-1 -4 -7 -11 -16 -21 -28 -36 -45 -55 -66 -79 -93 -108 -124 -141 -160 -180 -201 -223 -246 -271 -297 -323 -352 -381

 1+ 0+ 0+ 0+ 1+ 2+ 2+ 3+ 3+ 4+ 4+ 5+ 5+ 6+ 6+ 7+ 7+ 8+ 8+ 9+ 9+ 9+ 10+ 10+ 11+ 11+
 0 0 -2 -5 -10 -16 -22 -30 -39 -50 -61 -74 -88 -103 -119 -136 -155 -175 -196 -218 -241 -266 -292 -319 -347 -376

 1+ 0+ 0+ 0+ 0+ 0+ 0+ 0+ 0+ 0+ 0+ -1+ -1+ -1+ -1+ -1+ -1+ -1+ -1+ -2+ -2+ -2+ -2+ -2+ -2+ -2+
 1 0 0 -2 -6 -12 -19 -27 -36 -46 -58 -70 -84 -99 -116 -133 -152 -172 -193 -215 -238 -263 -289 -316 -344 -373

 1+ 0+ 0+ 0+ 0+ -1+ -2+ -3+ -4+ -5+ -5+ -6+ -7+ -8+ -9+ -9+ -10+ -11+ -12+ -13+ -13+ -14+ -15+ -16+ -16+ -17+
 2 0 0 -2 -5 -10 -17 -25 -34 -44 -56 -69 -83 -98 -114 -132 -150 -170 -191 -213 -237 -261 -287 -314 -342 -372

 1+ 0+ 0+ 0+ -1+ -3+ -4+ -6+ -8+ -9+ -11+ -12+ -14+ -15+ -17+ -18+ -19+ -21+ -22+ -24+ -25+ -26+ -28+ -29+ -30+ -32+
 3 0 -1 -2 -5 -10 -17 -25 -34 -44 -56 -69 -83 -98 -114 -132 -151 -170 -192 -214 -237 -262 -288 -315 -343 -372

 1+ -9+ -2+ -3+ -4+ -6+ -8+ -10+ -12+ -14+ -16+ -19+ -21+ -23+ -25+ -27+ -29+ -31+ -33+ -35+ -37+ -39+ -41+ -43+ -45+ -47+
 4 -2 -2 -4 -7 -12 -19 -27 -36 -46 -58 -71 -85 -100 -116 -134 -153 -173 -194 -216 -239 -264 -290 -317 -345 -374

 1+ -29+ -10+ -8+ -9+ -11+ -13+ -15+ -18+ -21+ -23+ -26+ -29+ -31+ -34+ -37+ -39+ -42+ -44+ -47+ -49+ -52+ -55+ -57+ -60+ -62+
 5 -9 -7 -8 -11 -16 -22 -30 -39 -50 -62 -74 -88 -104 -120 -138 -156 -176 -197 -220 -243 -268 -294 -321 -349 -378

 1+ -97+ -31+ -21+ -19+ -19+ -21+ -23+ -26+ -29+ -32+ -35+ -38+ -41+ -44+ -47+ -50+ -54+ -57+ -60+ -63+ -66+ -69+ -72+ -75+ -78+
 6 -24 -15 -15 -18 -22 -28 -36 -45 -55 -67 -80 -94 -109 -126 -143 -162 -182 -203 -226 -249 -274 -300 -327 -355 -384

 1+-261+ -77+ -46+ -36+ -34+ -34+ -35+ -37+ -40+ -43+ -46+ -49+ -53+ -56+ -60+ -63+ -67+ -70+ -74+ -77+ -81+ -85+ -88+ -92+ -95+
 7 -51 -30 -26 -27 -31 -37 -44 -53 -63 -75 -88 -102 -117 -133 -151 -170 -190 -211 -233 -257 -281 -307 -334 -362 -392

 1+-592+-164+ -90+ -65+ -56+ -52+ -52+ -53+ -55+ -57+ -60+ -63+ -67+ -70+ -74+ -78+ -82+ -85+ -89+ -93+ -97+-101+-105+-109+-114+
 8 -95 -52 -43 -41 -43 -48 -55 -64 -74 -85 -98 -111 -127 -143 -160 -179 -199 -220 -243 -266 -291 -317 -344 -372 -401

 1*****-313+-162+-111+ -90+ -80+ -75+ -74+ -74+ -75+ -78+ -80+ -84+ -87+ -91+ -95+ -99+-103+-107+-111+-115+-120+-124+-129+-133+
 9 -165 -85 -66 -60 -60 -63 -69 -77 -87 -98 -110 -124 -139 -155 -172 -191 -211 -232 -254 -278 -302 -328 -355 -383 -413
```

TABLE 14. X- AND Y-COMPONENT ERRORS DUE TO A 10-MILLISECOND ERROR IN ARRIVAL TIME AT MICROPHONE 2

WEIGHTED RANGE SOLUTION TO EVAL TOT LOCN ERROR XPER PCMB

DL	IP	IO	N	M	DEV	UP	IN	EZ	V1	V2	V3	TE
4.00	2	3	-9	25	1.000	10.00	5	0.0	0.00	0.02	0.10	50.00

2*	**********		-873*	-518*	-351*	-259*	-202*	-165*	-130*	-119*	-104*	-93*	-84*	-77*	-71*	-67*	-63*	-60*	-57*	-54*	-52*	-51*	-49*	-48*	-47*
-9	-476	440	330	260	220	194	176	163	154	147	142	139	136	135	135	135	136	137	139	141	144	147	150	153	157
2*	**********		-602*	-362*	-249*	-186*	-147*	-120*	-102*	-88*	-78*	-70*	-63*	-58*	-54*	-51*	-48*	-46*	-44*	-42*	-41*	-39*	-38*	-38*	-37*
-8	312	378	263	209	179	159	146	136	129	124	121	119	118	117	118	119	120	122	124	127	130	133	136	140	144
2*	*******	815*	-388*	-240*	-169*	-128*	-102*	-85*	-72*	-63*	-56*	-50*	-46*	-43*	-40*	-38*	-36*	-34*	-33*	-32*	-31*	-30*	-29*	-28*	-28*
-7	933	283	200	163	142	128	119	112	107	104	102	101	100	101	102	103	105	107	110	113	116	120	123	127	132
2*	*******	-456*	-239*	-149*	-108*	-84*	-68*	-57*	-49*	-43*	-38*	-35*	-32*	-30*	-28*	-26*	-25*	-24*	-23*	-22*	-22*	-21*	-21*	-20*	-20*
-6	395	196	146	124	110	101	95	90	87	85	84	84	84	86	87	89	91	94	97	100	104	107	111	116	120
2*	-772*	-221*	-124*	-86*	-65*	-51*	-42*	-35*	-31*	-27*	-24*	-22*	-21*	-19*	-18*	-17*	-16*	-16*	-15*	-15*	-14*	-14*	-14*	-14*	-13*
-5	923	175	101	91	85	77	73	70	69	68	68	69	70	71	73	76	79	82	85	88	92	96	100	104	109
2*	-233*	-89*	-59*	-45*	-35*	-28*	-23*	-20*	-17*	-15*	-14*	-13*	-12*	-11*	-10*	-10*	-9*	-9*	-9*	-8*	-8*	-8*	-8*	-8*	-7*
-4	102	72	68	64	60	57	54	53	52	53	53	55	56	59	61	64	67	70	73	77	81	85	89	94	98
2*	-41*	-28*	-24*	-19*	-15*	-13*	-10*	-9*	-8*	-7*	-6*	-5*	-5*	-5*	-4*	-4*	-4*	-4*	-3*	-3*	-3*	-3*	-3*	-3*	-2*
-3	35	40	44	43	41	39	38	37	38	39	40	42	44	47	49	52	56	59	63	66	70	75	79	83	88
2*	-3*	-6*	-6*	-5*	-4*	-3*	-2*	-2*	-1*	-1*	-1*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	1*	1*
-2	13	24	26	25	23	23	23	24	25	27	28	31	33	36	39	42	45	49	53	57	61	65	69	74	79
2*	1*	2*	1*	1*	1*	1*	1*	1*	1*	1*	2*	2*	2*	2*	2*	2*	3*	3*	3*	3*	3*	4*	4*	4*	4*
-1	4	5	7	7	8	9	10	12	14	16	18	21	23	26	29	33	36	40	43	47	51	56	60	65	70
2*	3*	1*	1*	2*	2*	2*	2*	2*	3*	3*	3*	3*	4*	4*	4*	4*	5*	5*	5*	6*	6*	6*	6*	7*	7*
0	-4	-5	-4	-3	-1	0	1	3	5	7	9	12	14	17	20	24	27	31	35	39	43	47	52	56	61
2*	0*	0*	0*	0*	1*	1*	1*	2*	2*	3*	3*	4*	4*	5*	5*	5*	6*	6*	7*	7*	7*	8*	8*	9*	9*
1	3	-2	-3	-7	-7	-6	-5	-4	-2	0	1	4	8	9	12	16	19	23	27	31	35	39	44	48	53
2*	3*	0*	0*	0*	0*	0*	0*	0*	1*	2*	2*	3*	4*	4*	5*	6*	6*	7*	7*	8*	9*	9*	10*	10*	11*
2	3	-1	-4	-7	-10	-10	-10	-10	-8	-7	-5	-2	0	2	5	8	12	15	19	23	27	31	36	41	43
2*	-1*	-1*	-2*	-2*	-3*	-3*	-2*	-1*	0*	0*	1*	2*	2*	3*	4*	5*	6*	7*	7*	8*	9*	10*	10*	11*	12*
3	-1	-2	-5	-8	-12	-14	-14	-14	-14	-12	-11	-9	-6	-4	-1	1	5	8	12	16	20	24	29	33	38
2*	-12*	-6*	-5*	-6*	-6*	-6*	-5*	-4*	-3*	-2*	-1*	0*	0*	2*	3*	4*	5*	6*	7*	8*	9*	10*	11*	11*	12*
4	-5	-6	-8	-11	-14	-17	-18	-19	-19	-18	-16	-14	-12	-10	-7	-4	-1	2	5	9	13	17	22	26	31
2*	-55*	-20*	-14*	-13*	-12*	-11*	-10*	-9*	-7*	-6*	-4*	-3*	-1*	0*	1*	2*	3*	5*	6*	7*	8*	9*	10*	11*	12*
5	-15	-13	-14	-16	-19	-21	-23	-23	-23	-23	-22	-20	-18	-16	-13	-10	-7	-4	0	3	6	11	15	19	24
2*	-170*	-52*	-31*	-24*	-21*	-19*	-17*	-15*	-13*	-11*	-9*	-7*	-5*	-3*	-1*	0*	1*	3*	4*	5*	7*	8*	9*	11*	12*
6	-42	-25	-23	-23	-25	-27	-28	-28	-29	-28	-27	-26	-24	-22	-19	-16	-13	-10	-6	-3	0	4	9	13	18
2*	-405*	-113*	-61*	-43*	-34*	-29*	-25*	-22*	-19*	-16*	-14*	-11*	-9*	-7*	-5*	-3*	-1*	0*	2*	4*	5*	7*	8*	10*	11*
7	-79	-48	-35	-33	-33	-33	-34	-34	-34	-34	-33	-31	-29	-27	-25	-22	-19	-16	-13	-9	-5	-1	2	7	11
2*	-824*	-214*	-108*	-71*	-54*	-44*	-37*	-32*	-27*	-24*	-20*	-17*	-14*	-11*	-9*	-6*	-4*	-2*	0*	1*	3*	5*	7*	8*	10*
8	-133	-69	-52	-46	-43	-42	-42	-41	-41	-40	-39	-37	-35	-33	-31	-28	-25	-22	-19	-15	-11	-7	-3	1	5
2*	********	-369*	-177*	-111*	-81*	-63*	-52*	-48*	-38*	-32*	-28*	-24*	-20*	-17*	-14*	-11*	-8*	-6*	-3*	-1*	0*	2*	5*	6*	8*
9	-205	-102	-73	-61	-56	-53	-51	-49	-48	-47	-45	-44	-42	-39	-37	-34	-31	-28	-25	-21	-17	-13	-9	-4	0

TABLE 15. X- AND Y-COMPONENT ERRORS DUE TO A 10-MILLISECOND ERROR IN ARRIVAL TIME AT MICROPHONE 3

```
WEIGHTED RANGE SOLUTION TO EVAL TGT LOCN ERROR XFER FCNS
BL     IP  IO  M   N   DXY    UP     IN  ZZ   V1    V2    V3    TE
4.00   3   8   -9  25  1.000  10.00  5   0.0  0.00  0.00  0.00  10.00
```

3*	******	-210*	-192*	-161*	-143*	-132*	-126*	-122*	-119*	-118*	-117*	-116*	-116*	-117*	-118*	-119*	-120*	-122*	-124*	-126*	-128*	-130*	-133*	-135*	-138*
-9	-921	40	60	74	83	93	103	114	125	137	149	162	175	189	204	220	236	253	271	289	309	329	351	375	398
3*	693*	-80*	-86*	-93*	-92*	-91*	-90*	-90*	-91*	-91*	-91*	-92*	-93*	-94*	-96*	-97*	-99*	-101*	-103*	-105*	-107*	-110*	-112*	-115*	-117*
-8	-125	13	34	48	60	72	84	96	108	120	133	145	159	173	188	203	219	236	254	273	292	313	334	356	379
3*	401*	0*	-33*	-50*	-57*	-61*	-64*	-67*	-68*	-70*	-71*	-72*	-74*	-75*	-77*	-79*	-80*	-82*	-84*	-87*	-89*	-91*	-93*	-96*	-98*
-7	-89	-8	13	29	43	56	69	82	94	106	118	131	145	158	173	189	205	222	240	258	278	298	319	341	364
3*	279*	32*	-9*	-26*	-39*	-42*	-46*	-49*	-51*	-53*	-54*	-56*	-57*	-59*	-61*	-62*	-64*	-66*	-68*	-70*	-72*	-74*	-76*	-78*	-81*
-6	-78	-21	0	16	31	45	58	70	82	94	106	119	132	146	160	176	192	209	226	245	265	285	306	328	351
3*	177*	33*	1*	-13*	-23*	-28*	-32*	-35*	-37*	-39*	-40*	-42*	-44*	-45*	-47*	-48*	-50*	-52*	-53*	-55*	-57*	-59*	-61*	-62*	-64*
-5	-62	-24	-6	9	24	38	50	62	73	85	96	109	121	135	149	164	180	197	215	233	253	273	294	316	339
3*	81*	19*	2*	-8*	-15*	-20*	-23*	-25*	-26*	-28*	-29*	-30*	-32*	-33*	-34*	-36*	-37*	-39*	-40*	-42*	-43*	-45*	-46*	-48*	-49*
-4	-42	-21	-7	7	21	34	45	56	66	77	88	100	112	126	140	155	170	187	205	223	242	263	284	306	329
3*	19*	6*	0*	-7*	-11*	-13*	-15*	-16*	-17*	-18*	-19*	-20*	-21*	-22*	-24*	-25*	-26*	-27*	-28*	-29*	-30*	-32*	-33*	-34*	-35*
-3	-21	-14	-3	9	22	32	41	51	60	70	81	92	104	117	131	146	162	178	196	214	233	254	275	297	320
3*	9*	0*	-3*	-5*	-7*	-8*	-8*	-9*	-10*	-11*	-11*	-12*	-13*	-13*	-14*	-15*	-16*	-16*	-17*	-18*	-19*	-19*	-20*	-21*	-22*
-2	-7	-7	3	14	23	31	38	46	55	64	74	85	97	110	124	138	154	171	188	206	226	246	267	289	312
3*	-3*	-2*	-2*	-2*	-2*	-3*	-3*	-3*	-4*	-4*	-4*	-5*	-5*	-5*	-6*	-6*	-6*	-7*	-7*	-7*	-8*	-8*	-8*	-9*	-9*
-1	5	10	14	18	23	28	34	41	49	58	68	79	91	104	117	132	148	164	181	200	219	239	260	282	305
3*	3*	2*	1*	1*	1*	1*	1*	1*	1*	1*	1*	1*	1*	1*	1*	1*	1*	1*	1*	2*	2*	2*	2*	2*	2*
0	4	7	10	13	17	22	29	36	44	53	63	74	85	98	112	127	142	159	176	194	214	234	255	277	300
3*	0*	1*	1*	2*	2*	3*	4*	4*	5*	5*	6*	6*	7*	8*	8*	9*	9*	10*	10*	11*	12*	12*	13*	13*	14*
1	-8	-5	-2	3	9	15	22	30	38	48	58	69	81	94	107	122	138	154	172	190	209	230	251	273	295
3*	5*	0*	0*	0*	2*	4*	5*	7*	8*	9*	10*	11*	13*	14*	15*	16*	17*	18*	19*	20*	21*	22*	23*	24*	25*
2	5	-3	-6	-4	1	8	16	24	33	43	53	65	77	90	104	119	134	151	168	187	206	226	248	270	292
3*	-8*	-3*	-3*	-1*	0*	3*	6*	8*	10*	12*	14*	16*	18*	20*	21*	23*	24*	26*	28*	29*	31*	32*	34*	35*	37*
3	-4	-6	-9	-8	-3	2	10	19	29	39	50	61	74	87	101	116	132	149	166	185	204	224	246	268	291
3*	-31*	-13*	-9*	-5*	-1*	2*	6*	9*	12*	15*	18*	21*	23*	25*	28*	30*	32*	34*	36*	38*	40*	42*	44*	46*	48*
4	-15	-13	-13	-12	-7	-1	6	15	25	36	47	59	72	85	99	115	131	147	165	184	203	224	245	267	290
3*	-118*	-35*	-19*	-11*	-5*	0*	5*	10*	14*	18*	22*	25*	28*	31*	34*	37*	40*	42*	45*	47*	50*	53*	55*	58*	60*
5	-39	-28	-19	-16	-11	-4	3	12	23	34	45	57	70	85	99	114	130	147	165	184	204	224	245	267	291
3*	-279*	-73*	-36*	-20*	-9*	-1*	5*	11*	16*	21*	26*	30*	34*	37*	41*	44*	48*	51*	54*	57*	60*	63*	66*	69*	72*
6	-69	-37	-27	-21	-14	-6	1	11	21	33	45	57	70	85	99	115	131	148	166	185	205	225	247	269	292
3*	-553*	-131*	-57*	-29*	-14*	-2*	6*	13*	20*	25*	31*	36*	40*	44*	49*	52*	56*	60*	64*	67*	71*	74*	78*	81*	85*
7	-115	-53	-35	-25	-16	-8	1	11	22	33	45	58	72	86	101	117	133	151	169	188	208	228	250	272	295
3*	-991*	-205*	-83*	-40*	-17*	-3*	7*	16*	24*	31*	37*	42*	47*	52*	57*	62*	66*	70*	74*	78*	82*	86*	90*	94*	98*
8	-163	-69	-43	-29	-18	-8	1	12	23	35	47	60	74	89	104	120	137	154	172	192	211	232	254	276	300
3*	******	-298*	-110*	-48*	-19*	-1*	11*	22*	30*	38*	44*	51*	56*	62*	67*	72*	77*	81*	86*	90*	95*	99*	103*	108*	112*
9	-233	-87	-50	-31	-18	-7	3	14	26	38	51	64	78	93	108	124	141	159	177	197	217	238	259	282	305

TABLE 16. X- AND Y-COMPONENT ERRORS DUE TO A 30-MILLISECOND ERROR IN ARRIVAL TIME AT MICROPHONE 1

```
WEIGHTED RANGE SOLUTION TO EVAL TGT LOCN ERROR XFER FCNS
BL      TP   IP   W    N   DXV     UP     TW     ZZ     V1     V2     V3     TF
4.00    1    8   -9   25  1.000   30.00   5      0.0    0.00   0.00   0.00   10.00

 1********************** 890+ 740+ 642+ 580+ 538+ 511+ 493+ 481+ 475+ 472+ 473+ 476+ 480+ 486+ 494+ 502+ 511+ 522+ 532+ 543+ 555+
-9 -678 -677 -560 -533 -501 -493 -498 -507 -526 -551 -582 -617 -657 -701 -749 -802 -858 -918 -981 **** **** **** **** **** ****

 1***************** 801+ 694+ 590+ 470+ 433+ 410+ 395+ 387+ 382+ 382+ 383+ 387+ 392+ 399+ 407+ 415+ 424+ 434+ 444+ 455+ 466+ 478+
-8 -570 -512 -467 -410 -397 -398 -408 -426 -449 -478 -511 -548 -590 -635 -685 -738 -795 -855 -920 -988 **** **** **** **** ****

 1*********** 720+ 520+ 429+ 349+ 338+ 319+ 308+ 302+ 300+ 301+ 304+ 308+ 314+ 321+ 328+ 337+ 346+ 355+ 365+ 375+ 386+ 396+ 407+
-7 -445 -372 -325 -308 -308 -318 -335 -357 -383 -414 -449 -488 -531 -577 -628 -682 -739 -800 -865 -934 **** **** **** **** ****

 1****** 873+ 410+ 322+ 274+ 251+ 238+ 230+ 227+ 227+ 230+ 233+ 239+ 245+ 251+ 259+ 267+ 276+ 284+ 293+ 303+ 312+ 322+ 332+ 342+
-6 -310 -285 -228 -226 -237 -254 -274 -299 -328 -360 -396 -436 -480 -527 -578 -632 -690 -752 -817 -886 -958 **** **** **** ****

 1+ 762+ 322+ 225+ 191+ 175+ 167+ 164+ 163+ 165+ 168+ 173+ 178+ 184+ 191+ 198+ 206+ 213+ 222+ 230+ 238+ 247+ 256+ 265+ 273+ 282+
-5 -179 -148 -151 -164 -182 -202 -225 -251 -281 -314 -351 -392 -436 -483 -535 -589 -648 -710 -775 -844 -914 -992 **** **** ****

 1+ 249+ 151+ 118+ 109+ 107+ 108+ 110+ 113+ 117+ 122+ 127+ 133+ 139+ 146+ 152+ 159+ 167+ 174+ 181+ 189+ 196+ 204+ 211+ 219+ 227+
-4 -75 -80 -98 -120 -140 -162 -186 -212 -243 -276 -313 -354 -399 -446 -498 -553 -611 -673 -739 -808 -881 -957 **** **** ****

 1+ 45+ 49+ 55+ 60+ 63+ 67+ 71+ 75+ 80+ 85+ 90+ 96+ 101+ 107+ 113+ 119+ 125+ 131+ 137+ 144+ 150+ 156+ 162+ 169+ 175+
-3 -22 -45 -69 -90 -109 -130 -150 -181 -211 -245 -282 -323 -367 -416 -467 -522 -581 -643 -709 -778 -851 -927 **** **** ****

 1+ 11+ 20+ 25+ 31+ 34+ 39+ 43+ 47+ 51+ 56+ 60+ 65+ 69+ 74+ 79+ 83+ 88+ 93+ 97+ 102+ 107+ 112+ 116+ 121+ 126+
-2 -12 -34 -53 -68 -85 -105 -128 -155 -185 -219 -257 -298 -342 -390 -442 -497 -556 -618 -684 -753 -826 -902 -982 **** ****

 1+ 0+ 5+ 9+ 13+ 17+ 20+ 23+ 26+ 29+ 32+ 36+ 39+ 42+ 45+ 48+ 51+ 54+ 58+ 61+ 64+ 67+ 70+ 73+ 76+ 79+
-1 -13 -23 -35 -48 -64 -84 -108 -134 -165 -199 -236 -278 -322 -371 -422 -478 -536 -599 -665 -734 -807 -883 -963 **** ****

 1+ 0+ 0+ 2+ 4+ 6+ 7+ 9+ 10+ 12+ 13+ 15+ 16+ 18+ 19+ 20+ 22+ 23+ 25+ 26+ 27+ 29+ 30+ 32+ 33+ 34+
 0 -1 -6 -17 -31 -48 -68 -92 -119 -150 -184 -222 -263 -308 -356 -408 -463 -522 -585 -650 -720 -793 -869 -949 **** ****

 1+ 0+ 0+ 0+ 0+ 0+ 0+ -1+ -1+ -2+ -2+ -3+ -3+ -4+ -4+ -4+ -5+ -5+ -6+ -6+ -7+ -7+ -7+ -8+ -8+ -9+
 1 0 -2 -8 -20 -37 -57 -81 -109 -139 -174 -212 -253 -298 -347 -399 -454 -513 -575 -641 -711 -784 -860 -940 **** ****

 1+ 0+ 0+ 0+ -2+ -4+ -7+ -10+ -12+ -15+ -17+ -20+ -22+ -25+ -27+ -30+ -32+ -34+ -36+ -39+ -41+ -43+ -45+ -48+ -50+ -52+
 2 0 -1 -6 -16 -31 -52 -76 -103 -134 -169 -207 -249 -294 -342 -394 -450 -509 -572 -638 -707 -780 -857 -936 **** ****

 1+ -1+ -1+ -2+ -5+ -10+ -14+ -19+ -24+ -28+ -33+ -38+ -42+ -46+ -51+ -55+ -59+ -63+ -67+ -72+ -76+ -80+ -84+ -88+ -92+ -96+
 3 -1 -3 -7 -17 -32 -52 -75 -103 -134 -169 -207 -249 -294 -343 -395 -451 -510 -573 -639 -708 -782 -858 -938 **** ****

 1+ -14+ -5+ -9+ -13+ -18+ -24+ -31+ -37+ -44+ -50+ -57+ -63+ -69+ -75+ -81+ -88+ -94+ -99+-105+-111+-117+-123+-129+-135+-140+
 4 -8 -9 -19 -23 -38 -57 -81 -108 -140 -175 -213 -255 -300 -349 -401 -457 -516 -579 -645 -715 -788 -865 -945 **** ****

 1+ -85+ -32+ -24+ -28+ -33+ -40+ -47+ -55+ -63+ -71+ -79+ -87+ -95+-103+-110+-118+-126+-133+-141+-149+-156+-164+-171+-179+-186+
 5 -28 -21 -25 -35 -49 -68 -92 -119 -151 -186 -224 -266 -311 -360 -413 -469 -528 -591 -657 -727 -800 -877 -957 **** ****

 1+-302+ -87+ -44+ -58+ -59+ -64+ -72+ -80+ -88+ -97+-106+-115+-124+-134+-143+-152+-161+-170+-180+-189+-198+-207+-216+-225+-234+
 6 -78 -47 -46 -54 -68 -86 -109 -137 -168 -202 -241 -283 -328 -377 -430 -486 -545 -608 -674 -744 -817 -894 -974 **** ****

 1+-828+-218+-148+-111+-102+-102+-107+-113+-121+-130+-140+-149+-159+-169+-180+-190+-201+-211+-222+-232+-243+-253+-264+-275+-285+
 7 -160 -92 -90 -83 -95 -112 -134 -161 -191 -226 -264 -306 -351 -400 -452 -508 -568 -631 -697 -767 -840 -917 -997 **** ****

 1******-508+-274+-199+-170+-159+-157+-160+-165+-173+-182+-191+-201+-212+-223+-234+-245+-257+-268+-280+-292+-303+-315+-327+-339+
 8 -298 -142 -130 -125 -132 -147 -167 -193 -222 -256 -294 -335 -380 -429 -481 -537 -596 -659 -725 -795 -868 -945 **** **** ****

 1******-949+-484+-339+-272+-241+-227+-223+-223+-228+-234+-242+-252+-262+-273+-284+-296+-308+-320+-333+-346+-358+-371+-384+-398+
 9 -485 -268 -202 -183 -182 -193 -210 -233 -261 -294 -331 -372 -416 -465 -516 -572 -631 -694 -760 -829 -902 -979 **** **** ****
```

TABLE 17. X- AND Y-COMPONENT ERRORS DUE TO A 30-MILLISECOND ERROR IN ARRIVAL TIME AT MICROPHONE 2

```
WEIGHTED RANGE SOLUTION TO EVAL TGT LOCN ERROR XFER FCNS
BL       IP   IR   M    N   RXY     UP      TW     ZZ    V1     V2     V3    TF
4.00     2    3   -9   25   1.000   30.00   5      0.0   0.00   0.00   0.00  10.00

 2+****-811+****************-741+-577+-467+-390+-333+-290+-257+-230+-209+-191+-177+-164+-153+-144+-136+-129+-122+-116+-111+-106+
-9 ****  972  845  732  627  553  501  463  434  413  396  384  375  368  363  360  359  358  359  360  362  364  367  369  372

 2+********************-731+-542+-428+-346+-290+-249+-218+-194+-175+-159+-146+-135+-126+-118+-111+-105+-100+ -95+ -90+ -86+ -82+
-8 ****  702  724  615  524  463  422  392  369  353  341  332  326  322  319  318  318  320  321  324  327  330  334  338  341

 2+****+****+****+-722+-502+-378+-299+-246+-208+-179+-158+-141+-127+-116+-107+-100+ -93+ -88+ -83+ -78+ -74+ -71+ -67+ -64+ -61+
-7 ****  867  611  491  422  378  347  324  308  296  288  282  279  277  277  278  280  282  285  289  293  297  302  306  311

 2+**********-718+-553+-325+-249+-200+-166+-141+-122+-108+ -97+ -88+ -81+ -75+ -70+ -65+ -61+ -58+ -55+ -52+ -49+ -47+ -45+ -43+
-6  180  692  482  375  330  300  278  262  251  244  239  236  235  236  237  240  243  247  251  256  261  266  271  276  282

 2+****-712+-395+-262+-195+-153+-124+-104+ -89+ -78+ -69+ -62+ -57+ -52+ -48+ -45+ -42+ -40+ -37+ -35+ -33+ -31+ -30+ -28+ -26+
-5  828  400  314  275  240  230  216  206  199  195  193  193  194  197  200  204  208  213  218  224  229  235  241  247  253

 2+-801+-279+-183+-136+-106+ -84+ -69+ -58+ -50+ -44+ -39+ -35+ -32+ -29+ -27+ -25+ -23+ -22+ -20+ -19+ -17+ -16+ -15+ -14+ -12+
-4  347  227  208  195  181  169  160  154  152  151  151  153  156  160  165  170  175  181  187  193  200  206  213  219  226

 2+-130+ -85+ -74+ -60+ -47+ -38+ -31+ -26+ -22+ -19+ -17+ -15+ -13+ -12+ -11+  -9+  -8+  -7+  -6+  -5+  -4+  -3+  -2+  -1+  -1+
-3  118  123  128  131  122  115  110  109  109  111  113  117  122  127  132  138  144  151  157  164  171  178  185  192  199

 2+ -11+ -19+ -19+ -16+ -12+  -9+  -7+  -6+  -4+  -3+  -2+  -1+   0+   0+   0+   1+   2+   3+   3+   4+   5+   6+   7+   7+   8+
-2   40   74   81   74   69   67   67   68   71   75   79   84   90   96  102  109  116  123  130  137  144  151  159  166  173

 2+  10+   8+   4+   3+   4+   4+   4+   4+   5+   5+   6+   7+   7+   8+   9+   9+  10+  11+  11+  12+  13+  14+  14+  15+  16+
-1   11   17   20   22   24   27   30   34   39   44   49   55   61   68   75   81   89   96  103  111  118  126  133  141  148

 2+   0+   4+   5+   6+   6+   7+   7+   8+   9+  10+  10+  11+  12+  13+  13+  14+  15+  16+  17+  18+  18+  19+  20+  21+  22+
 0  -12  -16  -14  -10   -6   -2    2    6   12   17   23   29   35   42   49   56   63   71   78   86   94  101  109  117  124

 2+   0+   0+   1+   2+   4+   4+   5+   7+   8+   9+  10+  12+  13+  14+  15+  16+  18+  19+  20+  21+  22+  23+  24+  25+  26+
 1   -1   -6  -15  -21  -22  -21  -18  -14  -10   -5    0    6   12   19   26   33   40   47   55   63   70   78   86   93  101

 2+   0+   0+  -1+  -2+  -2+  -1+   0+   2+   4+   6+   7+   9+  11+  13+  14+  16+  18+  19+  21+  22+  23+  25+  26+  27+  28+
 2    0   -3  -12  -23  -30  -33  -33  -32  -28  -24  -20  -14   -8   -2    4   11   18   25   32   40   48   55   63   70   78

 2+  -3+  -3+  -6+  -8+  -9+  -9+  -7+  -5+  -2+   0+   2+   4+   7+   9+  11+  13+  16+  17+  19+  21+  23+  25+  26+  28+  29+
 3   -8   -7  -15  -26  -36  -42  -45  -46  -44  -42  -38  -33  -28  -22  -16   -9   -2    4   11   18   26   33   41   48   56

 2+ -97+ -18+ -17+ -19+ -20+ -20+ -18+ -15+ -12+  -9+  -5+  -2+   0+   3+   6+   9+  11+  14+  16+  19+  21+  23+  25+  27+  28+
 4  -19  -15  -25  -35  -45  -52  -57  -59  -59  -58  -55  -51  -46  -41  -35  -29  -23  -16   -9   -2    5   12   19   27   34

 2+-172+ -61+ -44+ -39+ -37+ -35+ -32+ -29+ -25+ -20+ -16+ -12+  -8+  -4+  -1+   2+   5+   8+  11+  14+  17+  19+  22+  24+  26+
 5  -53  -60  -62  -50  -58  -65  -70  -73  -74  -73  -71  -68  -64  -60  -54  -49  -42  -36  -29  -22  -15   -8   -1    5   12

 2+-530+-181+ -97+ -75+ -65+ -58+ -52+ -46+ -41+ -35+ -30+ -25+ -20+ -15+ -10+  -6+  -2+   1+   4+   8+  11+  14+  17+  20+  22+
 6 -131  -72  -70  -72  -77  -82  -86  -89  -90  -90  -88  -86  -82  -78  -73  -68  -62  -56  -49  -43  -36  -29  -22  -15   -8

 2+****-381+-180+-133+-107+ -91+ -79+ -70+ -62+ -54+ -47+ -40+ -34+ -28+ -22+ -17+ -12+  -8+  -3+   0+   3+   7+  10+  14+  17+
 7 -251 -136 -120 -102 -102 -104 -106 -108 -108 -108 -107 -104 -101  -97  -92  -87  -81  -76  -69  -63  -56  -50  -43  -36  -30

 2+****-677+-317+-221+-167+-137+-116+-101+ -88+ -77+ -68+ -59+ -51+ -44+ -37+ -31+ -25+ -19+ -14+  -9+  -5+  -1+   2+   6+   9+
 8 -420 -215 -143 -142 -138 -131 -130 -130 -129 -128 -126 -124 -120 -116 -112 -107 -101  -96  -90  -84  -77  -71  -64  -58  -51

 2+**********-542+-350+-258+-190+-165+-141+-122+-107+ -94+ -82+ -72+ -63+ -55+ -47+ -40+ -33+ -27+ -22+ -16+ -11+  -7+  -3+   0+
 9 -627 -329 -222 -193 -178 -165 -160 -156 -154 -151 -148 -145 -141 -137 -133 -128 -122 -117 -111 -105  -99  -92  -86  -80  -73
```

TABLE 18. X- AND Y-COMPONENT ERRORS DUE TO A 30-MILLISECOND ERROR IN ARRIVAL TIME AT MICROPHONE 3

WEIGHTED RANGE SOLUTION TO EVAL TOT LOCN ERROR XFER FCNS

RL	IP	ID	W	N	DXY	UP	TH	ZZ	V1	V2	V3	TE
4.00	3	8	-9	25	1.000	30.00	5	0.0	0.00	0.00	0.00	10.00

3*	****	685*	-271*	-360*	-371*	-363*	-358*	-348*	-343*	-340*	-338*	-338*	-338*	-340*	-342*	-345*	-348*	-353*	-357*	-363*	-368*	-374*	-380*	-387*	-390*
-9	****	-216	70	163	218	253	280	325	360	396	432	470	509	549	591	635	682	730	780	832	887	944	****	****	****
3*	****	287*	-185*	-226*	-246*	-254*	-258*	-261*	-263*	-265*	-267*	-269*	-272*	-275*	-279*	-283*	-288*	-293*	-298*	-304*	-309*	-316*	-322*	-328*	-335*
-8	-893	-120	61	111	159	200	239	276	313	349	386	424	463	503	546	590	636	684	734	787	849	898	957	****	****
3*	****	188*	-60*	-127*	-158*	-175*	-187*	-194*	-200*	-204*	-208*	-212*	-216*	-220*	-225*	-230*	-234*	-240*	-245*	-251*	-256*	-262*	-268*	-274*	-281*
-7	-504	-93	31	69	117	160	199	237	273	310	346	384	422	463	505	549	595	643	693	746	800	857	916	978	****
3*	****	192*	-84*	-87*	-100*	-121*	-138*	-143*	-150*	-155*	-160*	-164*	-169*	-173*	-178*	-183*	-187*	-193*	-198*	-203*	-208*	-214*	-219*	-225*	-231*
-6	-308	-88	-13	40	87	130	169	206	242	277	313	349	387	427	469	512	558	606	656	709	763	820	879	941	****
3*	985*	111*	10*	-36*	-65*	-84*	-94*	-104*	-110*	-115*	-120*	-124*	-128*	-133*	-137*	-141*	-146*	-150*	-155*	-160*	-165*	-170*	-174*	-179*	-184*
-5	-203	-81	-44	24	70	111	148	183	218	250	284	320	357	396	437	480	526	573	623	676	730	787	846	907	971
3*	244*	60*	7*	-24*	-45*	-59*	-68*	-74*	-78*	-83*	-86*	-90*	-94*	-97*	-101*	-105*	-109*	-113*	-117*	-121*	-125*	-129*	-133*	-137*	-141*
-4	-125	-65	-21	20	63	100	134	165	196	227	260	294	330	369	409	452	497	544	594	646	701	757	816	878	941
3*	56*	19*	-2*	-20*	-32*	-40*	-45*	-49*	-52*	-55*	-58*	-61*	-64*	-67*	-70*	-73*	-76*	-79*	-82*	-85*	-88*	-91*	-95*	-98*	-101*
-3	-64	-43	-12	28	64	96	128	151	179	208	239	272	307	344	384	427	472	519	568	620	675	731	790	851	915
3*	9*	-1*	-9*	-17*	-21*	-24*	-26*	-28*	-30*	-32*	-34*	-36*	-38*	-40*	-42*	-44*	-46*	-48*	-50*	-52*	-54*	-56*	-59*	-61*	-63*
-2	-23	-21	10	44	76	92	118	138	163	190	219	252	286	323	363	405	449	496	546	598	652	709	767	829	892
3*	-10*	-9*	-7*	-7*	-8*	-9*	-10*	-11*	-11*	-12*	-13*	-14*	-15*	-16*	-17*	-18*	-19*	-20*	-21*	-22*	-23*	-24*	-25*	-26*	-26*
-1	16	30	44	56	69	84	102	123	147	173	202	233	268	304	344	386	430	477	526	578	632	689	748	809	873
3*	10*	8*	4*	3*	3*	3*	3*	3*	3*	3*	3*	4*	4*	4*	4*	5*	5*	5*	5*	6*	6*	6*	7*	7*	7*
0	13	22	31	40	52	68	84	106	130	156	185	217	251	288	327	369	414	461	510	562	616	673	732	793	856
3*	3*	3*	5*	7*	8*	10*	12*	13*	15*	17*	18*	20*	22*	23*	25*	27*	28*	30*	31*	33*	35*	36*	38*	39*	41*
1	-13	-16	-6	9	27	45	64	88	113	140	170	202	237	274	313	356	400	447	497	549	603	659	718	780	843
3*	0*	9*	0*	2*	7*	12*	14*	20*	24*	28*	31*	35*	38*	41*	44*	47*	50*	53*	56*	59*	62*	65*	68*	71*	74*
2	-2	-11	-10	-12	3	24	47	71	97	126	156	189	224	262	302	344	389	436	486	538	592	649	708	769	833
3*	-12*	-9*	-0*	-5*	1*	10*	17*	25*	31*	37*	43*	48*	53*	58*	62*	67*	72*	76*	81*	85*	89*	93*	98*	102*	106*
3	-18	-20	-27	-25	-12	6	30	56	83	113	144	178	214	252	293	336	381	429	478	531	585	642	701	762	826
3*	-36*	-29*	-27*	-17*	-6*	5*	18*	27*	36*	45*	53*	60*	67*	74*	80*	87*	93*	99*	105*	111*	116*	122*	127*	133*	138*
4	-59	-49	-41	-37	-25	-6	17	43	72	103	135	170	207	246	287	330	376	423	474	526	581	638	697	758	822
3*	-357*	-109*	-60*	-36*	-17*	0*	18*	28*	41*	53*	63*	73*	82*	90*	99*	107*	114*	122*	129*	137*	144*	151*	158*	164*	171*
5	-118	-73	-60	-50	-38	-16	7	34	64	95	129	164	202	241	283	327	373	421	472	524	579	637	696	758	821
3*	-893*	-235*	-119*	-63*	-32*	-7*	12*	30*	46*	61*	74*	86*	97*	108*	118*	127*	137*	146*	155*	163*	172*	180*	188*	197*	205*
6	-221	-117	-85	-66	-47	-24	0	28	58	91	125	162	200	240	283	327	373	422	473	526	581	638	698	760	823
3*	****	-835*	-180*	-99*	-40*	-15*	11*	34*	53*	71*	86*	101*	114*	126*	138*	150*	161*	171*	181*	191*	201*	211*	221*	230*	239*
7	-388	-173	-135	-83	-57	-31	-8	25	56	90	125	162	201	242	285	330	377	426	477	530	586	643	703	765	829
3*	****	-705*	-203*	-143*	-69*	-22*	12*	39*	63*	83*	101*	118*	133*	147*	161*	174*	186*	198*	210*	221*	233*	243*	254*	265*	275*
8	-567	-265	-159	-101	-67	-36	-6	55	57	92	128	166	206	247	291	336	383	433	484	538	593	651	711	773	837
3*	****	****	-880*	-100*	-91*	-27*	15*	48*	76*	99*	120*	138*	155*	171*	186*	201*	215*	228*	241*	253*	266*	278*	290*	302*	313*
9	-808	-309	-182	-121	-74	-40	-6	27	61	97	134	173	213	255	299	345	393	443	495	548	604	662	722	784	848

TABLE 19. X- AND Y-COMPONENT ERRORS DUE TO 3-MILLISECOND ERRORS IN ARRIVAL TIME AT MICROPHONES 1 AND 2

WEIGHTED RANGE SOLUTION TO EVAL TGT LOCN ERROR XFLN FCNS

WL	IP	ID	M	N	DAY	UP	IN	ZZ	V1	V2	V3	TE
4.00	1	8	-9	25	1.000	3.00	5	0.0	0.00	0.00	0.00	10.00

1+	-402+	-132+	-53+	-23+	-5+	0+	5+	10+	13+	16+	18+	20+	22+	24+	25+	27+	29+	30+	32+	33+	35+	36+	38+	39+	41+
-9	80	44	28	18	12	6	1	-2	-7	-11	-15	-20	-24	-29	-34	-39	-44	-50	-55	-61	-68	-74	-81	-88	-95
1+	-434+	-111+	-45+	-20+	-5+	0+	4+	8+	11+	13+	15+	17+	19+	20+	22+	23+	25+	26+	28+	29+	30+	32+	33+	35+	36+
-8	80	41	26	17	11	6	1	-2	-6	-10	-14	-19	-23	-28	-32	-37	-43	-48	-54	-60	-66	-72	-79	-86	-93
1+	-334+	-82+	-34+	-15+	-6+	0+	3+	6+	9+	11+	13+	15+	16+	18+	19+	20+	22+	23+	24+	25+	27+	28+	29+	30+	32+
-7	71	35	23	15	10	5	1	-2	-6	-10	-14	-18	-22	-27	-31	-36	-41	-47	-52	-58	-64	-71	-77	-84	-92
1+	-213+	-53+	-22+	-10+	-3+	0+	3+	6+	8+	9+	11+	12+	14+	15+	16+	17+	19+	20+	21+	22+	23+	24+	25+	26+	27+
-6	55	26	18	13	8	4	0	-3	-6	-10	-14	-18	-22	-26	-31	-36	-41	-46	-52	-57	-63	-70	-76	-83	-90
1+	-100+	-29+	-13+	-5+	-1+	1+	3+	5+	7+	8+	9+	11+	12+	13+	14+	15+	16+	17+	18+	19+	20+	21+	22+	23+	24+
-5	37	20	14	10	6	2	0	-4	-7	-11	-14	-18	-22	-26	-31	-35	-40	-45	-51	-57	-63	-69	-76	-83	-90
1+	-39+	-12+	-5+	-2+	0+	2+	3+	5+	6+	7+	8+	9+	10+	11+	12+	12+	13+	14+	15+	16+	17+	17+	18+	19+	20+
-4	20	13	9	7	3	0	-2	-5	-8	-11	-15	-18	-22	-26	-31	-35	-40	-45	-51	-56	-62	-69	-75	-82	-89
1+	-7+	-3+	-1+	0+	1+	2+	3+	4+	5+	6+	7+	7+	8+	9+	9+	10+	11+	11+	12+	13+	13+	14+	15+	15+	16+
-3	8	7	6	3	1	-1	-4	-6	-9	-12	-15	-19	-23	-27	-31	-36	-40	-46	-51	-57	-63	-69	-75	-82	-89
1+	0+	0+	0+	1+	2+	2+	3+	4+	4+	5+	5+	6+	6+	7+	7+	8+	8+	9+	9+	10+	10+	11+	11+	12+	13+
-2	2	3	2	0	-1	-3	-5	-8	-10	-13	-16	-20	-23	-27	-32	-36	-41	-46	-51	-57	-63	-69	-76	-83	-90
1+	1+	1+	1+	1+	2+	2+	2+	3+	3+	3+	4+	4+	4+	5+	5+	6+	6+	6+	7+	7+	7+	8+	8+	9+	9+
-1	0	0	-1	-2	-3	-5	-7	-9	-12	-14	-17	-21	-24	-28	-33	-37	-42	-47	-52	-58	-64	-70	-77	-83	-90
1+	0+	0+	0+	1+	1+	1+	1+	1+	2+	2+	2+	2+	3+	3+	3+	3+	3+	4+	4+	4+	4+	5+	5+	5+	5+
0	-1	-2	-3	-4	-5	-6	-8	-10	-13	-16	-19	-22	-26	-30	-34	-38	-43	-48	-53	-59	-65	-71	-78	-84	-92
1+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+	1+	1+	1+	1+	1+	1+	1+	1+	1+	1+	1+	2+	2+
1	0	0	-2	-4	-5	-7	-9	-12	-14	-17	-20	-23	-27	-31	-35	-40	-44	-50	-55	-61	-66	-73	-79	-86	-93
1+	0+	0+	0+	0+	0+	0+	0+	-1+	-1+	-1+	-1+	-1+	-1+	-1+	-1+	-1+	-1+	-1+	-1+	-1+	-1+	-1+	-1+	-1+	-1+
2	0	0	-1	-3	-6	-8	-10	-13	-15	-18	-22	-25	-29	-33	-37	-41	-46	-51	-57	-62	-68	-75	-81	-88	-95
1+	0+	0+	0+	-1+	-1+	-2+	-2+	-2+	-3+	-3+	-3+	-3+	-3+	-3+	-4+	-4+	-4+	-4+	-4+	-4+	-5+	-5+	-5+	-5+	-5+
3	0	-1	-2	-4	-5	-9	-11	-14	-17	-20	-23	-27	-31	-35	-39	-44	-48	-54	-59	-65	-71	-77	-83	-90	-97
1+	-5+	-2+	-2+	-3+	-3+	-4+	-4+	-5+	-5+	-5+	-6+	-6+	-6+	-6+	-7+	-7+	-7+	-7+	-8+	-8+	-8+	-9+	-9+	-9+	-9+
4	-2	-2	-3	-5	-8	-10	-13	-16	-19	-22	-26	-29	-33	-37	-41	-46	-51	-56	-62	-67	-73	-80	-86	-93	-100
1+	-25+	-9+	-7+	-6+	-7+	-7+	-7+	-8+	-8+	-8+	-9+	-9+	-9+	-10+	-10+	-10+	-11+	-11+	-12+	-12+	-12+	-13+	-13+	-14+	-14+
5	-8	-6	-6	-8	-10	-13	-16	-18	-22	-25	-28	-32	-36	-40	-44	-49	-54	-59	-65	-70	-76	-83	-89	-96	-103
1+	-78+	-25+	-15+	-13+	-12+	-12+	-12+	-12+	-12+	-12+	-13+	-13+	-13+	-14+	-14+	-14+	-15+	-15+	-16+	-16+	-17+	-17+	-18+	-18+	-19+
6	-19	-12	-11	-12	-14	-16	-19	-22	-25	-28	-32	-35	-39	-43	-48	-52	-57	-63	-68	-74	-80	-86	-93	-100	-107
1+	-191+	-56+	-32+	-23+	-20+	-18+	-18+	-17+	-17+	-17+	-18+	-18+	-18+	-18+	-19+	-19+	-20+	-20+	-21+	-21+	-22+	-22+	-23+	-23+	-24+
7	-37	-22	-18	-18	-19	-21	-23	-26	-29	-32	-35	-39	-43	-47	-52	-56	-61	-67	-72	-78	-84	-90	-97	-104	-111
1+	-392+	-110+	-58+	-40+	-32+	-28+	-26+	-25+	-24+	-24+	-24+	-24+	-24+	-24+	-24+	-25+	-25+	-25+	-26+	-26+	-27+	-28+	-28+	-29+	-30+
8	-63	-35	-28	-26	-26	-27	-29	-31	-34	-37	-40	-44	-48	-52	-56	-61	-66	-71	-77	-82	-88	-95	-101	-108	-115
1+	-712+	-196+	-99+	-65+	-50+	-42+	-37+	-35+	-33+	-32+	-31+	-31+	-30+	-30+	-31+	-31+	-31+	-32+	-32+	-33+	-33+	-34+	-34+	-35+	-36+
9	-90	-54	-41	-36	-34	-34	-35	-37	-40	-43	-46	-49	-53	-57	-61	-66	-71	-76	-82	-87	-93	-100	-106	-113	-120

TABLE 20. X- AND Y-COMPONENT ERRORS DUE TO 3-MILLISECOND ERRORS IN ARRIVAL TIME AT MICROPHONES 2 AND 3

WEIGHTED RANGE SOLUTION TO EVAL TGT LOCN ERROR XFER FCNS

BL	IP	ID	M	N	DAY	UP	IN	ZZ	V1	V2	V3	TE
4.00	3	8	-9	25	1.000	3.00	5	0.0	0.00	0.00	0.00	10.00

3+	******	-726+	-342+	-213+	-153+	-121+	-101+	-88+	-79+	-73+	-68+	-64+	-62+	-60+	-58+	-57+	-56+	-50+	-56+	-56+	-56+	-56+	-57+	-57+	-58+
-9	405	180	127	105	94	89	86	85	86	87	90	92	96	100	104	109	115	121	127	133	140	148	156	164	172
3+	******	-443+	-217+	-140+	-105+	-85+	-73+	-64+	-59+	-55+	-52+	-50+	-48+	-47+	-46+	-46+	-45+	-45+	-45+	-46+	-46+	-46+	-47+	-47+	-48+
-8	265	127	93	79	73	71	70	71	73	75	78	81	85	89	94	99	105	110	117	124	131	138	146	154	163
3+	-958+	-249+	-130+	-88+	-69+	-58+	-51+	-46+	-43+	-40+	-39+	-37+	-37+	-36+	-36+	-36+	-36+	-36+	-36+	-36+	-37+	-37+	-38+	-39+	-39+
-7	163	84	65	59	56	56	57	59	61	64	67	71	75	79	84	90	95	101	108	115	122	129	137	146	154
3+	-434+	-126+	-72+	-53+	-44+	-38+	-34+	-32+	-30+	-29+	-28+	-27+	-27+	-27+	-27+	-27+	-27+	-28+	-28+	-28+	-29+	-29+	-30+	-31+	-31+
-6	91	52	44	42	43	44	46	49	51	55	58	62	66	71	76	81	87	93	100	107	114	121	129	138	147
3+	-160+	-55+	-36+	-30+	-26+	-24+	-22+	-21+	-20+	-20+	-20+	-19+	-19+	-19+	-20+	-20+	-20+	-21+	-21+	-21+	-22+	-22+	-23+	-23+	-24+
-5	43	29	28	30	32	35	37	40	43	46	50	54	58	63	68	74	79	86	92	99	106	114	122	131	139
3+	-42+	-20+	-17+	-16+	-15+	-14+	-14+	-13+	-13+	-13+	-13+	-13+	-13+	-13+	-14+	-14+	-14+	-14+	-15+	-15+	-16+	-16+	-17+	-17+	-18+
-4	16	15	18	21	25	27	30	33	36	39	43	47	51	56	61	67	73	79	86	92	100	108	116	124	133
3+	-6+	-6+	-7+	-8+	-8+	-8+	-7+	-7+	-7+	-7+	-8+	-8+	-8+	-8+	-8+	-9+	-9+	-9+	-10+	-10+	-10+	-11+	-11+	-11+	-12+
-3	4	7	12	16	19	21	24	27	30	33	37	41	45	50	55	61	67	73	79	86	94	102	110	118	127
3+	-1+	-2+	-2+	-3+	-3+	-3+	-3+	-3+	-3+	-3+	-3+	-4+	-4+	-4+	-4+	-4+	-4+	-5+	-5+	-5+	-5+	-6+	-6+	-6+	-6+
-2	1	5	9	12	14	16	18	21	24	27	31	35	40	44	50	55	61	67	74	81	88	96	104	113	121
3+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+	-1+	-1+	-1+	-1+	-1+	-1+	-1+	-1+	-1+	-1+	-1+	-1+
-1	2	4	6	8	9	11	13	16	19	22	26	30	35	40	45	50	56	63	69	76	84	91	99	108	117
3+	1+	1+	1+	1+	1+	1+	1+	1+	1+	1+	1+	1+	1+	1+	1+	1+	2+	2+	2+	2+	2+	2+	2+	2+	2+
0	0	0	1	3	4	6	9	11	15	18	22	26	30	35	40	46	52	58	65	72	79	87	95	104	112
3+	0+	0+	0+	0+	1+	1+	1+	2+	2+	2+	3+	3+	3+	4+	4+	4+	4+	5+	5+	5+	6+	6+	6+	7+	7+
1	-1	-2	-2	-1	0	2	5	7	11	14	19	22	27	31	37	42	48	55	61	68	76	83	91	100	109
3+	0+	0+	0+	0+	0+	1+	1+	2+	3+	3+	4+	4+	5+	5+	6+	6+	7+	7+	8+	8+	9+	9+	10+	10+	11+
2	0	-1	-3	-3	-2	0	1	4	7	11	15	19	23	28	33	39	45	51	58	65	72	80	88	97	105
3+	-1+	-1+	-1+	-1+	0+	0+	1+	2+	3+	4+	4+	5+	6+	7+	8+	8+	9+	10+	11+	11+	12+	13+	13+	14+	15+
3	-1	-2	-4	-5	-4	-3	-1	1	4	8	12	16	20	25	31	36	42	49	55	62	70	77	85	94	103
3+	-13+	-5+	-4+	-3+	-2+	-1+	0+	1+	2+	4+	5+	6+	7+	8+	9+	10+	11+	12+	13+	14+	15+	16+	17+	18+	19+
4	-6	-5	-6	-7	-5	-5	-3	0	2	5	9	13	18	23	28	34	40	46	53	60	67	75	83	92	100
3+	-50+	-16+	-10+	-7+	-5+	-3+	-1+	0+	2+	3+	5+	6+	8+	9+	11+	12+	13+	14+	15+	17+	18+	19+	20+	21+	22+
5	-17	-11	-10	-9	-9	-7	-5	-3	0	3	7	11	16	21	26	32	38	44	51	58	66	73	81	90	99
3+	-129+	-37+	-20+	-13+	-9+	-5+	-3+	0+	1+	3+	5+	7+	9+	10+	12+	13+	15+	16+	18+	19+	21+	22+	23+	25+	26+
6	-42	-18	-15	-13	-11	-9	-7	-4	-1	1	5	10	14	19	25	30	37	43	50	57	64	72	80	89	97
3+	-261+	-75+	-34+	-21+	-14+	-9+	-5+	-2+	0+	3+	5+	7+	9+	11+	13+	15+	17+	19+	20+	22+	24+	25+	27+	28+	30+
7	-52	-26	-20	-17	-14	-12	-9	-6	-3	0	4	8	13	18	24	29	36	42	49	56	63	71	79	88	97
3+	-453+	-117+	-54+	-32+	-20+	-13+	-8+	-4+	0+	2+	5+	8+	10+	13+	15+	17+	19+	21+	23+	25+	27+	28+	30+	32+	34+
8	-75	-39	-27	-21	-17	-14	-11	-8	-4	0	3	8	12	18	23	29	35	41	48	55	63	71	79	88	96
3+	-737+	-176+	-79+	-45+	-28+	-18+	-11+	-5+	-1+	2+	5+	8+	11+	14+	16+	19+	21+	23+	26+	28+	30+	32+	34+	36+	38+
9	-102	-50	-34	-26	-21	-17	-13	-9	-5	-1	2	7	12	17	23	29	35	41	48	55	63	71	79	88	97

TABLE 21. X- AND Y-COMPONENT ERRORS DUE TO 3-MILLISECOND ERRORS IN ARRIVAL TIME AT MICROPHONES 2 AND 4

```
WEIGHTED RANGE SOLUTION TO EVAL TGT LOCN ERROR XFER FCNS
UL      IP    ID     M     N   DAY       UP       IN      ZZ      V1      V2      V3     TE
4.00     4     8    -9    25  1.000     3.00     5       0.0     0.00    0.00    0.00  10.00
```

9+	******+	-491+	-234+	-143+	-102+	-79+	-66+	-57+	-52+	-48+	-46+	-44+	-43+	-43+	-43+	-43+	-43+	-44+	-44+	-45+	-46+	-47+	-48+	-49+	-50+
-9	200	121	86	70	61	57	55	55	55	57	60	63	66	71	75	81	86	92	99	105	113	120	128	136	145
9+	******+	-321+	-155+	-97+	-70+	-56+	-47+	-42+	-39+	-36+	-35+	-34+	-34+	-34+	-34+	-35+	-35+	-36+	-37+	-37+	-38+	-39+	-40+	-41+	-42+
-8	169	91	86	54	49	46	45	45	47	49	52	55	59	64	69	74	80	86	92	99	106	114	122	130	139
9+	-737+	-196+	-97+	-63+	-45+	-38+	-33+	-30+	-28+	-27+	-26+	-26+	-26+	-27+	-27+	-28+	-28+	-29+	-30+	-31+	-31+	-32+	-33+	-34+	-35+
-7	125	66	49	41	35	36	36	37	39	42	45	49	53	58	63	68	74	80	87	93	101	108	116	125	133
9+	-395+	-109+	-57+	-38+	-29+	-25+	-22+	-21+	-20+	-19+	-19+	-20+	-20+	-21+	-21+	-22+	-22+	-23+	-24+	-25+	-25+	-26+	-27+	-28+	-29+
-6	83	45	35	30	29	28	29	31	33	36	39	43	48	52	57	63	69	75	82	89	96	103	112	120	129
9+	-175+	-53+	-30+	-22+	-18+	-15+	-14+	-14+	-14+	-14+	-14+	-14+	-15+	-15+	-16+	-16+	-17+	-18+	-18+	-19+	-20+	-21+	-21+	-22+	-23+
-5	49	29	24	22	21	22	23	25	28	31	35	39	43	48	53	58	64	71	77	84	92	99	107	116	124
9+	-57+	-22+	-15+	-11+	-10+	-9+	-9+	-9+	-9+	-9+	-10+	-10+	-10+	-11+	-11+	-12+	-13+	-13+	-14+	-14+	-15+	-15+	-16+	-17+	-17+
-4	24	17	16	15	15	16	18	21	23	27	31	35	39	44	49	55	61	67	74	81	88	96	104	112	121
9+	-11+	-7+	-6+	-5+	-5+	-5+	-5+	-5+	-5+	-6+	-6+	-6+	-7+	-7+	-8+	-8+	-9+	-9+	-9+	-10+	-10+	-11+	-11+	-12+	-12+
-3	9	10	10	10	11	12	14	17	20	23	27	31	36	41	46	52	58	64	71	78	85	93	101	109	118
9+	-1+	-1+	-1+	-1+	-2+	-2+	-2+	-2+	-3+	-3+	-3+	-3+	-4+	-4+	-4+	-5+	-5+	-5+	-5+	-6+	-6+	-6+	-7+	-7+	-7+
-2	3	6	6	6	7	9	12	14	17	21	25	29	34	38	44	49	55	61	68	75	82	90	98	107	115
9+	1+	0+	0+	0+	0+	0+	0+	0+	-1+	-1+	-1+	-1+	-1+	-1+	-1+	-1+	-2+	-2+	-2+	-2+	-2+	-2+	-2+	-2+	-3+
-1	0	0	1	3	5	7	10	13	16	19	23	27	32	37	42	47	53	60	66	73	81	88	96	105	113
9+	-1+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+	1+	1+	1+	1+	1+	1+	1+	1+	1+
0	0	0	1	3	4	6	9	11	15	18	22	26	30	35	40	46	52	58	65	72	79	87	95	,103	112
9+	1+	0+	0+	1+	1+	1+	1+	1+	2+	2+	2+	2+	3+	3+	3+	3+	4+	4+	4+	4+	4+	5+	5+	5+	5+
1	1	2	2	3	4	6	8	11	14	17	21	25	30	34	40	45	51	57	64	71	78	86	94	102	111
9+	0+	0+	0+	1+	1+	2+	2+	3+	3+	4+	4+	4+	5+	5+	6+	6+	6+	7+	7+	8+	8+	9+	9+	9+	10+
2	-2	-2	0	2	4	6	8	11	14	17	21	25	29	34	39	45	51	57	64	71	78	86	94	102	111
9+	-6+	-2+	0+	1+	2+	3+	3+	4+	5+	5+	6+	6+	7+	8+	8+	9+	10+	10+	11+	11+	12+	13+	13+	14+	14+
3	-6	-5	-2	0	3	5	8	11	14	17	21	25	29	34	39	45	51	57	64	71	78	86	94	102	111
9+	-27+	-7+	-2+	0+	2+	4+	5+	6+	6+	7+	8+	9+	10+	10+	11+	12+	13+	13+	14+	15+	16+	17+	17+	18+	19+
4	-14	-8	-4	-1	2	5	8	11	14	18	21	26	30	35	40	46	52	58	65	72	79	87	95	103	112
9+	-66+	-15+	-4+	0+	3+	5+	6+	7+	9+	10+	11+	11+	12+	13+	14+	15+	16+	17+	18+	19+	20+	21+	22+	23+	24+
5	-23	-11	-5	-1	1	5	8	11	15	18	22	27	31	36	41	47	53	59	66	73	80	88	96	104	113
9+	-112+	-23+	-6+	0+	4+	7+	8+	10+	11+	12+	13+	15+	16+	17+	18+	19+	20+	21+	22+	23+	24+	25+	26+	27+	29+
6	-30	-13	-6	-1	2	5	9	12	16	20	24	28	33	38	43	49	55	61	67	74	82	90	98	106	115
9+	-154+	-26+	-4+	3+	7+	10+	12+	13+	15+	16+	17+	18+	19+	20+	22+	23+	24+	25+	26+	28+	29+	30+	31+	33+	34+
7	-34	-13	-5	0	3	7	10	14	18	22	26	30	35	40	45	51	57	63	70	77	84	92	100	108	117
9+	-190+	-20+	1+	8+	12+	14+	16+	18+	19+	20+	21+	23+	24+	25+	26+	27+	29+	30+	31+	33+	34+	35+	37+	38+	39+
8	-37	-10	-3	1	5	9	13	16	20	24	28	33	38	43	48	54	60	66	72	80	87	95	103	111	120
9+	-234+	0+	15+	19+	20+	22+	23+	24+	25+	26+	27+	28+	29+	30+	32+	33+	34+	35+	37+	38+	40+	41+	43+	44+	46+
9	-41	-5	1	5	9	13	16	20	24	28	32	36	41	46	51	57	63	69	76	83	90	98	106	114	123

TABLE 22. X- AND Y-COMPONENT ERRORS DUE TO 3-MILLISECOND ERRORS IN ARRIVAL TIME AT MICROPHONES 2 AND 5

```
WEIGHTED RANGE SOLUTION TO EVAL TGT LOCN ERROR XFER FCNS
NC     IP   ID   M    N   DAY     UP     IN    ZZ    V1     V2     V3    TE
4.00   3    5   -9   25   1.000   3.00   5     0.0   0.00   0.00   0.00  10.00
```

5+	******	-447+	-207+	-122+	-81+	-59+	-45+	-37+	-31+	-26+	-23+	-21+	-20+	-19+	-18+	-18+	-17+	-17+	-17+	-17+	-17+	-18+	-18+	-18+	-19+
-9	102	110	76	59	49	42	38	35	32	31	30	30	30	30	31	32	34	35	37	39	42	44	47	50	53
5+	******	-311+	-145+	-86+	-58+	-43+	-33+	-27+	-22+	-19+	-17+	-16+	-15+	-14+	-14+	-14+	-14+	-14+	-14+	-14+	-14+	-15+	-15+	-15+	-16+
-8	166	89	62	48	40	35	31	29	27	26	25	25	26	26	27	29	30	32	34	36	39	41	44	47	50
5+	-765+	-200+	-95+	-58+	-40+	-29+	-23+	-19+	-16+	-14+	-13+	-12+	-11+	-11+	-11+	-11+	-11+	-11+	-11+	-11+	-12+	-12+	-12+	-13+	-13+
-7	132	68	48	38	32	28	25	23	22	21	21	21	22	23	24	26	27	29	31	34	36	39	42	45	48
5+	-426+	-116+	-58+	-37+	-25+	-19+	-15+	-12+	-11+	-9+	-9+	-8+	-8+	-8+	-8+	-8+	-8+	-8+	-9+	-9+	-9+	-10+	-10+	-10+	-11+
-6	92	49	36	29	25	22	20	18	17	17	17	18	19	20	21	23	25	27	29	32	34	37	40	43	46
5+	-193+	-55+	-32+	-21+	-15+	-12+	-9+	-8+	-7+	-6+	-6+	-6+	-6+	-6+	-6+	-6+	-6+	-6+	-7+	-7+	-7+	-8+	-8+	-8+	-8+
-5	55	32	25	22	19	16	15	14	13	14	14	15	16	17	19	21	23	25	27	30	32	35	38	41	44
5+	-63+	-24+	-15+	-11+	-8+	-6+	-5+	-4+	-4+	-4+	-4+	-4+	-4+	-4+	-4+	-4+	-4+	-5+	-5+	-5+	-5+	-6+	-6+	-6+	-6+
-4	27	19	17	15	13	12	10	10	10	10	11	12	14	15	17	19	21	23	25	28	31	34	37	40	43
5+	-11+	-8+	-6+	-5+	-3+	-3+	-2+	-2+	-2+	-2+	-2+	-2+	-2+	-2+	-3+	-3+	-3+	-3+	-3+	-4+	-4+	-4+	-4+	-4+	-5+
-3	10	11	11	10	9	7	7	7	7	8	9	10	12	13	15	17	19	22	24	27	30	33	36	39	42
5+	-1+	-1+	-1+	-1+	-1+	0+	0+	0+	-1+	-1+	-1+	-1+	-1+	-1+	-1+	-2+	-2+	-2+	-2+	-2+	-2+	-2+	-3+	-3+	-3+
-2	3	6	6	5	4	3	3	4	5	6	7	9	10	12	14	16	18	21	23	26	29	32	35	38	41
5+	1+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+	-1+	-1+	-1+	-1+	-1+	-1+	-1+	-1+	-1+
-1	1	1	0	0	0	0	1	2	3	5	6	8	9	11	13	15	18	20	23	25	28	31	34	38	41
5+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+
0	-2	-3	-2	-2	-1	0	0	2	3	4	6	7	9	11	13	15	18	20	23	25	28	31	34	37	41
5+	-1+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+	1+	1+	1+	1+	1+	1+	1+	1+	1+
1	1	1	0	0	0	0	1	2	3	5	6	8	9	11	13	15	18	20	23	25	28	31	34	38	41
5+	1+	1+	1+	1+	1+	0+	0+	0+	1+	1+	1+	1+	1+	1+	1+	2+	2+	2+	2+	2+	2+	2+	3+	3+	3+
2	3	6	6	5	4	3	3	4	5	6	7	9	10	12	14	16	18	21	23	26	29	32	35	38	41
5+	11+	8+	6+	5+	3+	3+	2+	2+	2+	2+	2+	2+	2+	2+	3+	3+	3+	3+	3+	4+	4+	4+	4+	4+	5+
3	10	11	11	10	9	7	7	7	7	8	9	10	12	13	15	17	19	22	24	27	30	33	36	39	42
5+	63+	24+	15+	11+	8+	6+	5+	4+	4+	4+	4+	4+	4+	4+	4+	4+	4+	5+	5+	5+	5+	6+	6+	6+	6+
4	27	19	17	15	13	12	10	10	10	10	11	12	14	15	17	19	21	23	25	28	31	34	37	40	43
5+	193+	55+	32+	21+	15+	12+	9+	8+	7+	6+	6+	6+	6+	6+	6+	6+	6+	6+	7+	7+	7+	8+	8+	8+	8+
5	55	32	25	22	19	16	15	14	13	14	14	15	16	17	19	21	23	25	27	30	32	35	38	41	44
5+	426+	116+	58+	37+	25+	19+	15+	12+	11+	9+	9+	8+	8+	8+	8+	8+	8+	8+	9+	9+	9+	10+	10+	10+	11+
6	92	49	36	29	25	22	20	18	17	17	17	18	19	20	21	23	25	27	29	32	34	37	40	43	46
5+	765+	200+	95+	58+	40+	29+	23+	19+	16+	14+	13+	12+	11+	11+	11+	11+	11+	11+	11+	11+	12+	12+	12+	13+	13+
7	132	68	48	38	32	28	25	23	22	21	21	21	22	23	24	26	27	29	31	34	36	39	42	45	48
5+	******	311+	145+	86+	58+	43+	33+	27+	22+	19+	17+	16+	15+	14+	14+	14+	14+	14+	14+	14+	14+	15+	15+	15+	16+
8	166	89	62	48	40	35	31	29	27	26	25	25	26	26	27	29	30	32	34	36	39	41	44	47	50
5+	******	447+	207+	122+	81+	59+	45+	37+	31+	26+	23+	21+	20+	19+	18+	18+	17+	17+	17+	17+	17+	18+	18+	18+	19+
9	102	110	76	59	49	42	38	35	32	31	30	30	30	30	31	32	34	35	37	39	42	44	47	50	53

TABLE 23. X- AND Y-COMPONENT ERRORS DUE TO 3-MILLISECOND ERRORS IN ARRIVAL TIME AT MICROPHONES 2 AND 6

WEIGHTED RANGE SOLUTION TO EVAL TGT LOCN ERROR XFER FCNS

DL	IP	ID	M	N	DAY	UP	IW	ZZ	V1	V2	V3	TE
4.00	6	8	-9	25	1.030	3.00	5	0.0	0.00	0.00	0.00	10.00

0+	*******	-461+	-211+	-121+	-79+	-54+	-38+	-27+	-19+	-13+	-8+	-4+	0+	2+	5+	7+	10+	12+	14+	16+	18+	19+	21+	23+	25+
-9	195	115	78	59	48	39	32	26	20	15	10	5	0	-5	-10	-15	-21	-27	-33	-39	-45	-52	-59	-66	-74
0+	*******	-326+	-150+	-88+	-57+	-40+	-28+	-20+	-14+	-9+	-5+	-2+	0+	3+	5+	7+	9+	11+	13+	14+	16+	17+	19+	20+	22+
-8	100	94	65	50	40	33	27	22	17	12	7	2	-2	-6	-12	-17	-22	-28	-34	-40	-46	-53	-60	-67	-75
0+	-821+	-211+	-100+	-60+	-40+	-28+	-20+	-14+	-9+	-6+	-3+	0+	1+	3+	5+	7+	8+	10+	11+	13+	14+	15+	17+	18+	19+
-7	142	72	51	40	33	27	22	17	13	9	4	0	-4	-9	-14	-19	-24	-30	-35	-41	-48	-54	-61	-68	-76
0+	[illegible]	-122+	-61+	-38+	-25+	-18+	-13+	-9+	-6+	-3+	-1+	0+	2+	4+	5+	6+	8+	9+	10+	11+	12+	13+	14+	16+	17+
-6	98	52	38	31	25	21	17	13	9	5	1	-2	-6	-11	-16	-21	-26	-31	-37	-43	-49	-56	-63	-70	-77
0+	-202+	-51+	-34+	-22+	-16+	-11+	-8+	-5+	-3+	-1+	0+	1+	3+	4+	5+	6+	7+	8+	9+	10+	10+	11+	12+	13+	14+
-5	56	34	27	23	20	16	13	9	5	2	-1	-5	-9	-14	-18	-23	-28	-34	-39	-45	-51	-58	-64	-71	-79
0+	-65+	-25+	-16+	-12+	-8+	-6+	-4+	-2+	0+	0+	1+	2+	3+	4+	4+	5+	6+	7+	7+	8+	8+	9+	10+	10+	11+
-4	28	20	18	17	14	11	8	5	2	-1	-4	-8	-12	-16	-21	-26	-31	-36	-42	-47	-53	-60	-67	-74	-81
0+	-12+	-8+	-7+	-5+	-3+	-2+	-1+	0+	0+	1+	1+	2+	2+	3+	4+	4+	4+	5+	5+	6+	6+	7+	7+	8+	8+
-3	10	11	12	11	9	6	3	1	-1	-5	-5	-11	-15	-19	-24	-28	-33	-39	-44	-50	-56	-62	-69	-76	-83
0+	-1+	-1+	-1+	-1+	0+	0+	0+	0+	0+	1+	1+	1+	2+	2+	2+	3+	3+	3+	3+	4+	4+	4+	4+	5+	5+
-2	3	7	7	5	3	1	0	-3	-5	-8	-11	-15	-19	-23	-27	-32	-36	-42	-47	-53	-59	-65	-72	-79	-86
0+	1+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+	1+	1+	1+	1+	1+	1+	1+	1+	1+	1+	1+	2+	2+
-1	1	1	1	0	-1	-2	-4	-7	-9	-12	-15	-18	-22	-26	-30	-35	-40	-45	-50	-56	-62	-68	-75	-82	-89
0+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+	0+	-1+	-1+	-1+	-1+	-1+	-1+	-1+
0	-1	-2	-3	-4	-5	-6	-8	-10	-13	-16	-19	-22	-26	-30	-34	-38	-43	-48	-54	-60	-66	-72	-79	-85	-93
0+	0+	0+	0+	-1+	-1+	-1+	-1+	-1+	-2+	-2+	-2+	-2+	-2+	-3+	-3+	-3+	-3+	-3+	-4+	-4+	-4+	-4+	-4+	-5+	-5+
1	-1	-3	-5	-6	-8	-10	-12	-14	-17	-20	-23	-26	-30	-34	-38	-42	-47	-52	-58	-63	-70	-76	-82	-89	-97
0+	-1+	-2+	-2+	-3+	-3+	-4+	-4+	-4+	-4+	-4+	-5+	-5+	-5+	-6+	-6+	-6+	-6+	-7+	-7+	-7+	-8+	-8+	-8+	-9+	-9+
2	-1	-3	-6	-9	-11	-13	-16	-18	-21	-24	-27	-30	-34	-38	-42	-47	-51	-57	-62	-68	-74	-80	-87	-94	-101
0+	-5+	-5+	-6+	-6+	-7+	-7+	-7+	-8+	-8+	-8+	-8+	-9+	-9+	-9+	-10+	-10+	-10+	-11+	-11+	-11+	-12+	-12+	-13+	-13+	-14+
3	-2	-5	-8	-11	-14	-17	-20	-22	-25	-28	-31	-35	-38	-42	-47	-51	-56	-61	-67	-72	-79	-85	-91	-98	-106
0+	-30+	-15+	-13+	-13+	-13+	-12+	-12+	-12+	-12+	-13+	-13+	-13+	-13+	-14+	-14+	-14+	-15+	-15+	-16+	-16+	-17+	-17+	-18+	-18+	-19+
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0+	-109+	-40+	-27+	-23+	-21+	-20+	-19+	-19+	-19+	-18+	-18+	-19+	-19+	-19+	-19+	-20+	-20+	-20+	-21+	-21+	-22+	-22+	-23+	-24+	-24+
5	-27	-19	-19	-21	-24	-27	-29	-32	-35	-38	-42	-45	-49	-53	-57	-62	-67	-72	-78	-83	-89	-96	-102	-109	-116
0+	-283+	-91+	-54+	-41+	-34+	-31+	-29+	-28+	-27+	-26+	-26+	-25+	-25+	-25+	-25+	-26+	-26+	-26+	-27+	-27+	-28+	-28+	-29+	-30+	-30+
6	-55	-35	-30	-30	-32	-34	-36	-39	-41	-45	-48	-51	-55	-59	-64	-68	-73	-78	-84	-89	-96	-102	-108	-115	-123
0+	-503+	-177+	-96+	-68+	-54+	-47+	-42+	-39+	-37+	-35+	-34+	-34+	-33+	-33+	-33+	-33+	-33+	-33+	-34+	-34+	-35+	-35+	-36+	-36+	-37+
7	-94	-55	-46	-42	-42	-43	-44	-46	-49	-52	-55	-58	-62	-66	-70	-75	-80	-85	-90	-96	-102	-109	-115	-122	-129
0+	*******	-311+	-161+	-107+	-82+	-68+	-59+	-54+	-50+	-47+	-45+	-44+	-43+	-42+	-42+	-41+	-41+	-41+	-42+	-42+	-42+	-43+	-43+	-44+	-45+
8	-142	-85	-65	-57	-54	-54	-54	-56	-58	-60	-63	-66	-70	-74	-78	-83	-87	-92	-98	-104	-110	-116	-122	-129	-137
0+	*******	-502+	-252+	-162+	-120+	-96+	-82+	-73+	-66+	-62+	-58+	-56+	-54+	-53+	-52+	-51+	-51+	-51+	-51+	-51+	-51+	-51+	-52+	-52+	-53+
9	-199	-119	-59	-76	-70	-67	-66	-67	-68	-70	-73	-75	-79	-83	-87	-91	-96	-101	-106	-112	-118	-124	-130	-137	-144

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APPENDIX

THE WEIGHTED RANGE EQUATION SOLUTION

Given microphone positions $(x, y, z)_i$, arrival time t_i, target position (X, Y, Z), shot time T, effective mean air velocity componets $(u, v, w)_i$ and sound speed c_i, we can write the equation connecting these as follows:

$$\left[\left(X - x_i\right) + u_i\left(t_i - T\right)\right]^2 + \left[\left(Y - y_i\right) + v_i\left(t_i - T\right)\right]^2$$

$$+ \left[\left(Z - z_i\right) + w_i\left(t_i - T\right)\right]^2 - c_i^2\left(t_i - T\right)^2 = e_i \ . \qquad \text{(A1)}$$

With real data, there may be errors in our determination of any of the subscripted variables in the left-hand member, so that the e_i are generally nonzero. Expansion and rearrangement yield

$$R_i^2 - P_i^2 = e_i \ , \qquad \text{(A2)}$$

where, denoting the effective speed of sound travel toward each microphone by s_i,

$$R_i^2 = \left(X - x_i\right)^2 + \left(Y - y_i\right)^2 + \left(Z - z_i\right)^2 \ , \qquad \text{(A3)}$$

$$P_i^2 = s_i^2\left(t_i - T\right)^2 \ , \qquad \text{(A4)}$$

$$s_i^2 = \left(c_i^2 - u_i^2 - v_i^2 - w_i^2\right) - \left[2\Big/\left(t_i - T\right)\right]$$

$$\times \left[u_i\left(X - x_i\right) + v_i\left(Y - y_i\right) + w_i\left(Z - z_i\right)\right] . \qquad \text{(A5)}$$

Thus defined, the weighted range equation solution seeks those values of the unknown target coordinates and shot time (X, Y, Z, T) for which

$$\sum_{i=1}^{N} W_i e_i^2 = \text{minimum} . \tag{A6}$$

For the purposes of this study, y_i, z_i, u_i, v_i, w_i, and Z are taken to be zero, all c_i are assumed equal to a single value (the speed of sound at an effective temperature of 10°C), and $x_{i+1}-x_i$ is assumed to be a constant, 1350 meters. Based on prior experimentation with real sound ranging data to determine the best exponent n, W_i is defined as follows:

$$W_i = R_i^n \Big/ \sum_{i=1}^{N} R_i^n , \tag{A7}$$

$$n = -5 . \tag{A8}$$

The solution to (A6) is obtained by an iterative computation, using conventional least squares methods and treating the W_i as constants during each approximation.

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